Preface

The science of computing has come a long way since the late 1930s, when John Vincent Atanasoff and Clifford Berry began work on the first electronic digital computer. One marvels to see how the science has advanced from the days of Charles Babbage, who developed the Difference Engine in the 1820s, and, later proposed the Analytical Engine. Computer science was and continues to be an intriguing field filled with interesting stories, colorful personalities, and incredible innovations.

Ever since their invention, computers have had a profound impact on society and the ways in which humans conduct business and financial matters, fight wars and maintain peace, provide goods and services, predict events (e.g., earthquakes, the weather, global warming), monitor security and safety, and a host of other applications too numerous to mention. Plus, the personal computer revolution, beginning in the 1980s, has brought computers into many homes and schools. This has helped students find new ways to prepare reports, conduct research, and study using computerized methods. In the new millennium, the role that computers play in society continues to grow.

The World of Computer Science

In preparing this encyclopedia, I came across references to the early work on the IBM System/360 series of computers, which featured capacities of 65,000 to 16 million bytes (4 byte-words) of main storage and disk storage of several million to tens or hundreds of million bytes. At the same time, I opened the Sunday paper in February of 2002 and scanned the ads for personal computers, announcing memories of several hundred million bytes and disk storage of gigabytes. The cost of the 360 series ranged from fifty to several hundred thousand dollars to more than a million. Prices for the computers advertised in my Sunday paper ranged from several hundred dollars to a few thousand. The IBM 360 series was released in 1964. If a similar breakthrough occurred in education or automobile manufacturing (a factor of 1000, on the conservative side), a year in college would cost $20, as would a good model car! This, of course, is not the case.

However, computer hardware is not the entire story. Machines all need software, operating systems, applications software, and the like. While a person was hard pressed to get a line drawing or a bar chart on the screen 25 years ago, someone today has a choice of presentation software (slides or projections of the computer screen), desktop publishing, spreadsheets, and the like, much of which comes bundled with the system.

In fact, today one can purchase, for a few thousand dollars, more equipment and software than the Department of Information Science and

Telecommunications at my school (the University of Pittsburgh) or, for that matter, the entire university, could buy, when I first arrived in 1974. This is, indeed, an extraordinary era to have been a part of and witnessed. However, this does not happen in a vacuum. In this encyclopedia we aim to detail the people, activities, products, and growth of knowledge that have helped computer science evolve into what it is today.

Volume Breakdown

The organization of this encyclopedia reflects the history and application of the field. Our first volume in this series is dedicated to the history of computing. Its subtitle is *Foundations: Ideas and People.* The second volume describes *Software and Hardware*, while the third addresses *Social Applications.* The fourth is appropriately subtitled the *Electronic Universe* as it looks at such developments and inventions as the Internet, ubiquitous computing (embedded computing), and miniaturization.

While the intent is to give an exhaustive view of the field, no encyclopedia of this size, or, for that matter, ten times its size, could provide a complete rendering of the developments, events, people, and technology involved. Hence, the four volumes provide a representative selection of the people, places, and events involved. The encyclopedia was developed from a U.S. point of view, but we trust that the articles herein are not intentionally biased and, hopefully, do justice to innovations and contributions from elsewhere in the world. A brief look at each volume of the encyclopedia follows.

Volume 1

Volume I discusses the foundations of computer science, including computing history and some important innovators. Among the people are American inventor Herman Hollerith (1860–1929), the designer of punched card and punched card equipment; English mathematician Charles Babbage (1791–1871), the inventor of the Difference Engine and the proposed Analytical Engine, a precursor of the stored program computer; English noblewoman Ada Byron King, the Countess of Lovelace (1815–1852), the first "computer programmer"; American executive Thomas J. Watson Sr. (1874–1956), early chief of the IBM Corporation; and American mathematician Grace Hopper (1906–1992), who helped in the development of COBOL (COmmon Business Oriented Language) and developed one of its predecessors, FLOW-MATIC, and is the person who allegedly coined the term "computer bug."

✶Explore further in Hollerith, Herman; Babbage, Charles; Lovelace, Ada Byron King, Countess of; Watson, Thomas J., Sr; and Hopper, Grace.

Within Volume 1, various groups and organizations are discussed. These include the Association for Computing Machinery (ACM), which brings together people from around the globe to exchange ideas and advance computer science; the Institute of Electrical and Electronic Engineers (IEEE), which serves as the world's largest technical professional association, with more than 350,000 members; and the IBM Corporation, Apple Computer Inc., and the Microsoft Corporation, which all contributed to the start of the personal computer (PC) revolution. Among the more general articles the reader will find those concerning topics such as early pioneers, featuring primarily American and European scientists and their work; language generations, focusing on the evolution of computer languages; and computer generations, discussing early machines such as the ENIAC (Electronic

✶Explore further in Association for Computing Machinery; Institute of Electrical and Electronic Engineers (IEEE); IBM Corporation; Apple Computer, Inc.; Microsoft Corporation; Early Pioneers; Generations, Languages; and Generations, Computers.

Numerical Integrator and Computer) and the EDVAC (Electronic Discrete Variable Automatic Computer).

Finally, other articles of general interest in Volume 1 concern the history and workings of supercomputers; the development of the mouse; the question of computer security; the beginnings of the Internet; and the basics of digital and analog computing. The government's role is explained in articles on the U.S. Census Bureau and funding research projects. In addition, mathematical tools such as the binary number system and the slide rule as well as innovations such as France's Minitel are also featured.

✶Explore further in Supercomputers; Mouse; Security; Internet; Digital Computing; Analog Computing; Census Bureau; Government Funding, Research; Binary Number System; Slide Rule; Minitel.

Volume 2

Volume 2 describes software and hardware. Articles cover topics from system analysis and design, which is the cornerstone of building a system, to operating systems, compilers, and parallel processing, which discuss some of the technical aspects of computing. Telecommunication subjects range from network design to wireless technology to ATM transmission, while application-oriented articles include pattern recognition, personal digital assistants (PDAs), and computer music. Essays concerning software products include object-oriented languages, client/server technology, invasive programs, and programming.

✶Explore further in System Analysis; Systems Design; Operating Systems; Compilers; Parallel Processing; Network Design; Wireless Technology; ATM Transmission; Pattern Recognition; Personal Digital Assistants; Music, Computer; Object-Oriented Languages; Client/Server Systems; Invasive Programs; and Programming.

Among the people featured in Volume 2 are John Bardeen (1908–1991), Walter H. Brattain (1902–1987), and William B. Shockley (1910–1989), inventors of the transistor; English mathematician George Boole (1815–1864), developer of Boolean logic; and Alexander Graham Bell (1847–1922), inventor of the telephone. Rounding out Volume 2 are the technical aspects of hardware-related topics, including coding techniques, digital logic design, and cellular technology.

✶Explore further in Bardeen, John, Brattain, Walter H., and Shockley, William B.; Boole, George; Boolean Algebra; Bell, Alexander Graham; Coding Techniques; Codes; Digital Logic Design; and Cellular Technology.

Volume 3

In Volume 3, the emphasis is on social applications. From fashion design to meteorology, the use of computers impacts our everyday lives. For example, computer technology has greatly influenced the study of biology, molecular biology, physics, and mathematics, not to mention the large role it plays in air traffic management and aircraft flight control, ATM machines and magnetic stripe cards for shopping and business. Businesses, large and small, have significantly benefited from applications that track product growth, costs, and the way products are managed. Volume 3 essays also explore the computer's role in medical image analysis and legal systems, while our use of computers in everyday life and our means of interacting with them are addressed in subjects such as library applications and speech recognition.

✶Explore further in Fashion Design; Weather Forecasting; Biology; Molecular Biology; Physics; Mathematics; Aircraft Traffic Management; Aircraft Flight Control; ATM Machines; Magnetic Stripe Cards; Project Management; Economic Modeling; Process Control; Productivity Software; Integrated Software; Image Analysis: Medicine; Legal Systems; Library Applications; Speech Recognition.

Volume 3 addresses our aesthetic and intellectual pursuits in areas such as composing music, playing chess, and designing buildings. Yet the advancements of computer sciences go much further as described in articles about agriculture, geographic information systems, and astronomy. Among the people featured in the volume are American inventor Al Gross (1918–2001), the "father of wireless"; Hungarian mathematician Rózsa Péter (1905–1977), promoter of the study of recursive functions; and American author Isaac Asimov (1920–1992), famed science fiction writer who wrote extensively about robots.

✶Explore further in Music Composition; Chess Playing; Architecture; Agriculture; Geographic Information Systems; Astronomy; Gross, Alfred J.; Péter, Rózsa; Asimov, Isaac.

Volume 4

✶Explore further in Internet: History; Internet: Applications; Internet: Backbone; Molecular Computing; Artificial Life; Mobile Computing; Cryptography; E-banking; E-books; E-commerce; E-journals and E-publishing; Information Access; Information Overload; Ethics; Copyright; and Patents.

Volume 4 delves into our interconnected, networked society. The Internet is explored in detail, including its history, applications, and backbone. Molecular computing and artificial life are discussed, as are mobile computing and encryption technology. The reader will find articles on electronic banking, books, commerce, publishing, as well as information access and overload. Ethical matters pertaining to the electronic universe are also addressed.

✶Explore further in Photography; Art; Cybercafe; Social Impact; Data Mining; Data Warehousing; Java Applets; JavaScript; Agents; Visual Basic.

Volume 4 extends our aesthetic interest with articles on photography and the use of computers in art. Readers will learn more about how cybercafes keep friends and family connected as well as the type of social impact that computers have had on society. Data gathering, storage, and retrieval are investigated in topics such as data mining and data warehousing. Similarly, Java applets, JavaScript, agents, and Visual Basic are featured.

✶Explore further in Marconi, Guglielmo; Shannon, Claude E.; Glushkov, Victor M.

Among the people highlighted in Volume 4 are Italian physicist Guglielmo Marconi (1874–1937), inventor of wireless communications; American engineer Claude E. Shannon (1916–2001), a pioneer of information theory; and Soviet mathematician Victor M. Glushkov (1923–1982), who advanced the science of cybernetics.

The Many Facets of Computer Science

Computer science has many interesting stories, many of which are told in this volume. Among them are the battle between John Atanasoff and John Mauchley and J. Presper Eckert Jr. over the patent to the electronic digital computer and regenerative memory, symbolized and embodied in the lawsuits between Sperry-Rand (Mauchley-Eckert) and Honeywell (Atanasoff) and Sperry-Rand (Mauchley-Eckert) and CDC (Atanasoff). The lawsuits are not covered here, but the principal actors are. And there is Thomas J. Watson's prediction, possibly apocryphal, of the need ("demand") for 50 computers worldwide! Plus, Ada Byron King, Countess of Lovelace, became famous for a reason other than being British poet Lord George Gordon Byron's daughter. And German inventor Konrad Zuse (1910–1995) saw his computers destroyed by the Allies during World War II, while Soviet mathematician Victor M. Glushkov (1923–1982) had an institute named after him and his work.

✶Explore further in Zuse, Konrad.

✶Explore further in Data Processing; Nanocomputing; Mainframes; E-mail; Abacus.

Scientific visualization is now a topic of interest, while data processing is passé. Nanocomputing has become a possibility, while mainframes are still in use and e-mail is commonplace in many parts of the world. It has been a great half-century or so (60 some years) for a fledgling field that began, possibly, with the Abacus!

Organization of the Material

Computer Sciences contains 286 entries that were newly commissioned for this work. More than 125 people contributed to this set, some from academia, some from industry, some independent consultants. Many contributors are from the United States, but other countries are represented including Australia, Canada, Great Britain, and Germany. In many cases, our contributors have written extensively on their subjects before, either in books or journal articles. Some even maintain their own web sites providing further information on their research topics.

Most entries in this set contain illustrations, either photos, graphs, charts, or tables. Many feature sidebars that enhance the topic at hand or give a glimpse into a topic of related interest. The entries—geared to high school students and general readers—include glossary definitions of unfamiliar terms to help the reader understand complex topics. These words are highlighted in the text and defined in the margins. In addition, each entry includes a bibliography of sources of further information as well as a list of related entries in the encyclopedia.

Additional resources are available in the set's front and back matter. These include a timeline on significant events in computing history, a timeline on significant dates in the history of programming and markup and scripting languages, and a glossary. An index is included in each volume—Volume 4 contains a cumulative index covering the entire *Computer Sciences* encyclopedia.

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Roger R. Flynn
Editor in Chief

Contributors

Tom Abel
Penn State University, University Park, PA

Martyn Amos
University of Liverpool, United Kingdom

Richard Archer
Pittsburgh, PA

Pamela Willwerth Aue
Royal Oak, MI

Nancy J. Becker
St. John's University, New York

Mark Bedau
Reed College, Portland, OR

Pierfrancesco Bellini
University of Florence, Italy

Gary H. Bernstein
University of Notre Dame, Notre Dame, IN

Anne Bissonnette
Kent State University Museum, Kent, OH

Kevin W. Bowyer
University of Notre Dame, Notre Dame, IN

Stefan Brass
University of Giessen, Germany

Barbara Britton
Windsor Public Library, Windsor, Ontario, Canada

Kimberly Mann Bruch
San Diego Supercomputer Center, University of California, San Diego

Ivan Bruno
University of Florence, Italy

Dennis R. Buckmaster
Pennsylvania State University, University Park, PA

Dan Burk
University of Minnesota, Minneapolis, MN

Guoray Cai
Pennsylvania State University, University Park, PA

Shirley Campbell
University of Pittsburgh, Pittsburgh, PA

Siddharth Chandra
University of Pittsburgh, Pittsburgh, PA

J. Alex Chediak
University of California, Berkeley, CA

Kara K. Choquette
Xerox Corporation

John Cosgrove
Cosgrove Communications, Pittsburgh, PA

Cheryl L. Cramer
Digimarc Corporation, Tualatin, OR

Anthony Debons
University of Pittsburgh, Pittsburgh, PA

Salvatore Domenick Desiano
NASA Ames Research Center (QSS Group, Inc.)

Ken Doerbecker
Perfection Services, Inc.; WeirNet LLC; and FreeAir Networks, Inc.

Judi Ellis
KPMG, LLP, Pittsburgh, PA

Karen E. Esch
Karen Esch Associates, Pittsburgh, PA

Ming Fan
University of Notre Dame, Notre Dame, IN

Jim Fike
Ohio University, Athens, OH

Ida M. Flynn
University of Pittsburgh, Pittsburgh, PA

Roger R. Flynn
University of Pittsburgh, Pittsburgh, PA

H. Bruce Franklin
Rutgers University, Newark, NJ

Thomas J. Froehlich
Kent State University, Kent, OH

Chuck Gaidica
WDIV-TV, Detroit, MI

G. Christopher Hall
PricewaterhouseCoopers

Gary Hanson
Kent State University, Kent, OH

Karen Hartman
James Monroe Center Library, Mary Washington College, Fredericksburg, VA

Melissa J. Harvey
Carnegie Mellon University, Pittsburgh, PA

Albert D. Helfrick
Embry-Riddle Aeronautical University, Daytona Beach, FL

Stephen Hughes
University of Pittsburgh, Pittsburgh, PA

Bruce Jacob
University of Maryland, College Park, MD

Radhika Jain
Georgia State University, Atlanta, GA

Wesley Jamison
University of Pittsburgh at Greensburg

Sid Karin
San Diego Supercomputer Center, University of California, San Diego

Declan P. Kelly
Philips Research, The Netherlands

Betty Kirke
New York, NY

Mikko Kovalainen
University of Jyväskylä, Finland

Paul R. Kraus
Pittsburgh, PA

Prashant Krishnamurthy
University of Pittsburgh, Pittsburgh, PA

Marina Krol
Mount Sinai School of Medicine, New York, NY

Susan Landau
Sun Microsystems Inc., Mountain View, CA

Nicholas C. Laudato
University of Pittsburgh, Pittsburgh, Pennsylvania

George Lawton
Eutopian Enterprises

Cynthia Tumilty Lazzaro
Pinnacle Training Corp., Stoneham, MA

Joseph J. Lazzaro
Massachusetts Commission for the Blind, Boston, MA

John Leaney
University of Technology, Sydney, Australia

Robert Lembersky
Ann Taylor, Inc., New York, NY

Terri L. Lenox
Westminster College, New Wilmington, PA

Joyce H-S Li
University of Pittsburgh, Pittsburgh, PA

Michael R. Macedonia
USA STRICOM, Orlando, FL

Dirk E. Mahling
University of Pittsburgh, Pittsburgh, PA

Cynthia J. Martincic
St. Vincent College, Latrobe, PA

Michael J. McCarthy
Carnegie Mellon University, Pittsburgh, PA

Ann McIver McHoes
Carlow College, Pittsburgh PA

Genevieve McHoes
University of Maryland, College Park, MD

John McHugh
CERT™ Coordination Center, Software Engineering Institute, Carnegie Mellon University, Pittsburgh, PA

Donald M. McIver
Northrop Grumman Corporation, Baltimore, MD

Maurice McIver
Integrated Databases, Inc., Honolulu, HI

William J. McIver, Jr.
University at Albany, State University of New York

Trevor T. Moores
University of Nevada, Las Vegas

Christopher Morgan
Association for Computing Machinery, New York, NY

Bertha Kugelman Morimoto
University of Pittsburgh, Pittsburgh, PA

Tracy Mullen
NEC Research Inc., Princeton, NJ

Paul Munro
University of Pittsburgh, Pittsburgh, PA

Stephen Murray
University of Technology, Sydney, Australia

Carey Nachenberg
Symantec Corporation

John Nau
Xceed Consulting, Inc., Pittsburgh, PA

Paolo Nesi
University of Florence, Italy

Kai A. Olsen
Molde College and University of Bergen, Norway

Ipek Özkaya
Carnegie Mellon University, Pittsburgh, PA

Bob Patterson
Perfection Services, Inc.

Robert R. Perkoski
University of Pittsburgh, Pittsburgh, PA

Thomas A. Pollack
Duquesne University, Pittsburgh, PA

Guylaine M. Pollock
IEEE Computer Society; Sandia National Laboratories, Albuquerque, NM

Wolfgang Porod
University of Notre Dame, Notre Dame, IN

Anwer H. Puthawala
Park Avenue Associates in Radiology, P.C., Binghamton, NY

Mary McIver Puthawala
Binghamton, NY

Sudha Ram
University of Arizona, Tucson, AZ

Edie M. Rasmussen
University of Pittsburgh, Pittsburgh, PA

Robert D. Regan
Consultant, Pittsburgh, PA

Allen Renear
University of Illinois, Urbana-Champaign

Sarah K. Rich
Pennsylvania State University, University Park, PA

Mike Robinson
Sageforce Ltd., Kingston on Thames, Surrey, United Kingdom

Elke A. Rudensteiner
Worcester Polytechnic Institute, Worcester, MA

Frank R. Rusch
University of Illinois at Urbana-Champaign

William Sherman
National Center for Supercomputing Applications, University of Illinois at Urbana-Champaign

Marc Silverman
University of Pittsburgh, Pittsburgh, PA

Munindar P. Singh
North Carolina State University, Raleigh, NC

Cindy Smith
PricewaterhouseCoopers, Pittsburgh, PA

Barry Smyth
Smart Media Institute, University College, Dublin, Ireland

Amanda Spink
Pennsylvania State University, University Park, PA

Michael B. Spring
University of Pittsburgh, Pittsburgh, PA

Savitha Srinivasan
IBM Almaden Research Center, San Jose, CA

Igor Tarnopolsky
Westchester County Department of Laboratories and Research, Valhalla, NY

George A. Tarnow
Georgetown University, Washington, DC

Lucy A. Tedd
University of Wales, Aberystwyth, Wales, United Kingdom

Umesh Thakkar
National Center for Supercomputing Applications, University of Illinois at Urbana-Champaign

Richard A. Thompson
University of Pittsburgh, Pittsburgh, PA

James E. Tomayko
Carnegie Mellon University, Pittsburgh, PA

Christinger Tomer
University of Pittsburgh, Pittsburgh, PA

Upkar Varshney
Georgia State University, Atlanta, GA

Jonathan Vos Post
Webmaster <http://magicdragon.com>

Tom Wall
Duke University, Durham, NC
Brett A. Warneke
University of California, Berkeley, CA
Patricia S. Wehman
University of Pittsburgh, Pittsburgh, PA
Isaac Weiss
University of Maryland, College Park, MD
Martin B. Weiss
University of Pittsburgh, Pittsburgh, PA
Jeffrey C. Wingard
Leesburg, VA
Victor L. Winter
University of Nebraska at Omaha
Charles R. Woratschek
Robert Morris University, Moon Township, PA
Peter Y. Wu
University of Pittsburgh, Pittsburgh, PA
William J. Yurcik
Illinois State University, Normal, IL
Gregg R. Zegarelli
Zegarelli Law Group, P.C.