THE COMPUTER MUSEUM REPORT

VOLUME 21

WINTER 1987/88

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Capital Campaign

64K or more

Apollo Computer, Inc.
C. Gordon Bell
Control Data Corporation
Cullinet Software, Inc.
Data General
Gardner Hendrie
Mitchell Kapor
Carver Mead
Kenneth Olsen
John William Poduska, Sr.
Wang Laboratories

32K or more

American Telephone &
Telegraph
Bank of America
Henry Burkhardt
ComputerLand
Kenneth Fisher
International Data Group
Burge Jamieson
Mitre Corporation
Russell Noftsker
Robert Noyce
Robert M. Metcalfe
Fontaine K. Richardson

16K or more

American Management
Systems
Anonymous
Clark Baker
The Boston Globe
Howard Cannon
David Donaldson
Doug Drane
David K. Dyer
Bruce Edwards
Index Systems
August Klein
Thomas Knight
James L. McKenney
NEC Corporation
David & Pat Nelson
Paul & Katherine Severino
Ron Smart
William Spencer
Charles E. Sporck
Ivan Sutherland
System One
Chris Terman
Minoru Tonai
Stephen Watson
Daniel Weinreb

8K or more

AFIPS
Harlan E. & Lois Anderson
Erich & Renee Bloch
Winston R. Hindle, Jr.
Theodore & Ruth Johnson
John Allen Jones
Stan Olsen
Russell Planitzer
Doug Ross
Grant & Dorrit Saviers
Edward Schwartz
Software Results Corp.
Erwin Tomash
Xerox Foundation

4K or more

Charles & Connie
Bachman
Gene Brewer
Roger and Mary Cady
R. Steve Cheheyl
Robert & Eleanor Chinn
Pat Clark
Robert G. Claussen
William Congleton
Alex d'Arbeloff
Arnaud de Vitry
Robert Everett
Ford Motor Company
Jay W. Forrester
William Foster
General Systems Group
Gaston Snow & Ely
Bartlett
Peter Hirshberg
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Kramer
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Lacey
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Ralph and Linda Lin-
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Robert Lucky
John Norris Maguire
Richard D. Mallery
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Meditech
Allen Michels
Microsoft
Robert M. Morrill
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New York Air, Inc.
Nolan Norton Company
John L. Payne
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Regis McKenna, Inc.
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Stratus Computer Corp.
Del Thorndike and Steve
Teicher
3Com Corporation
Jean De Valpine
Charles & Angela Waite
Harvey W. Wiggins, Jr.
William Wolfson

The Computer Museum
Museum Wharf
300 Congress Street
Boston, MA 02210

Joint Collecting Agreement

We have signed a collaborative agreement with the Smithsonian Institution, National Museum of American History, which promises to enhance the computing collections of both institutions.

"This is the first such formal joint collecting agreement the Smithsonian has made with a museum of the stature of The Computer Museum," said Dr. Arthur Molella, chairman of the Department of the History of Science and Technology, of the Smithsonian's National Museum of American History and a member of The Computer Museum's Board of Directors. He further explained, "The field is so large and there is so much to do that it's necessary for us to make agreements in important collecting fields with the leading specialized museums."

The joint arrangement with the Division of Computers, Information, and Society of the National Museum of American History is broad in scope, affecting historical research, preservation and exhibitry. We will cooperate in creating a common catalog and database of our collections. This is being carried out by a group composed of David Allison and Jon Eklund from the National Museum of American History and Gwen Bell and Lynn Hall from The Computer Museum.

The common goal in our collecting agreement is to make sure that all the important artifacts are preserved. Considering that computers are now entering their fifth generation and that the classes range from supercomputers to personal computers, the amount of material worth saving is growing. Cooperative collecting is essential for preservation.

The Scientific Instrument Commission of the Union Internationale d'Histoire et de Philosophie des Sciences is also cooperating in the effort to develop a complete listing of computer artifacts held around the world. While the collection of The Computer Museum is international, many national and specialized museums preserve many significant machines from their regions. For example, The Science Museum, Kensington, has much of the known Babbage equipment and The Deutsches Museum, Munich, has a collection of the machines built by Konrad Zuse. The Computer Museum is proud to have the NEAC 2201, one of the first transistorized computers in Japan built by NEC, components of EDSAC, Maurice Wilkes' Cambridge University computer that is the first fully operational stored program machine, and other non-U.S. computers. One of the goals of The Computer Museum is to show that computer innovations are not unique to one country, to one company, or to any one institution.

Saving the history does not just mean collecting artifacts. For each artifact, a technical file is also needed. Such material includes manuals, notebooks, photographs, and other accounts of the development and use of the machine.

This report lists new acquisitions to the collections of the Museum. The listing illustrates the diversity of the collection. We have chosen to feature some ephemera on the cover, because this material is often thrown out or thought to have little value. On the contrary, ephemera are important because they can quickly evoke the spirit of an era. Don't throw out your memorabilia. Send it to us. Do it all at once, or one at a time. Several times a year, we receive a small envelope from Phil Dorn — it always has a surprise spec card from an early computer or some other piece of ephemera. When Lynn Hall, the registrar and I open it, we generally smile the rest of the day. You too can make our days happy.

Gwen Bell
Founding President

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Cover: *A random sampling from the Museum's collection of ephemera provided from the desk drawers, basements, and attics of Richard Beers, Gordon Bell, David Corbishly, Phil Dorn, Jack Edmonton, and John D. Recob. Photo: Jerry Rabinowitz*

The Collection

New acquisitions from September 1985 through September 1987. Personal computers acquired between September 1985 and August 1986 are listed in Volume 17. Prior acquisitions are listed in Volumes 1, 5 and 10.

Computers

Applicon Graphics Systems,
Model701 (X785.86)
Gift of AT & T Network Systems

Atari, Inc.,
2600 Original Development System (X725.86)
Gift of Ronald E. Milner

BMCInternational,
if800 Model 20/20H (X807.87)
Gift of Roy Gibbon

Control Data Corporation,
CDC 1604 (X859.87)
Gift of Jim Payne

Convergent Technologies,
WorkSlate (X839.87)
Gift of Allen Michels

Data General Corporation,
MPT 87 Computer (X633.85)
Gift of Data General Corporation

Electronics Associates, Inc.,
EAI 16-31R (X806.87)
Gift of Tom Alexander

Electronics Associates, Inc.,
EAI 580 Analog/Hybrid Computing System (X661.86)
Gift of Foxboro Company

Electronics Associates, Inc.,
EAI TR-20 (X790.86)
Gift of S. J. Levanti

Heath Company,
Heathkit EC-1 Analog Educational Computer (X735.86)
Gift of David J. Pedersen

Heathkit,
H-1 Educational Computer (X799.86)
Gift of John Fitzpatrick

International Business Machines Corporation,
6/442 Office System (X670.86)
Gift of Matrix Corporation

Intel Corporation,
MCS-4 System (X651.86)
Gift of Joshua Horwitz

Intel Corporation,
Intellec 800 Microcomputer Development System (X624.85)
Gift of Intel Corporation

Interact Electronics,
16K Microcomputer (X778.86)
Gift of Russell O. Wheeler

Jupiter Cabtab Ltd.,
Ace Computer (X773.86)
Gift of Donald A. Gaubatz

Melard Technologies,
Access Portable Computer (X777.86)
Gift of Melard Technologies, Inc.

MIT Artificial Intelligence Laboratory,
CADR (X842.87)
Gift of MIT Artificial Intelligence Laboratory

MIT Lincoln Laboratory,
LINC (X834.87), (X835.87)
Gift of Michigan State University

Multitech Industrial Corporation,
Model MPF-II Micro-Professor Home Computer (X626.85)
Gift of Clive Bolton

National Cash Register,
NCR 299 (X781.86)
Gift of Glier's Meats Inc.

NEC Corporation,
NEAC 2203 (X800.86)
Gift of NEC Corporation

Prime Computer, Inc.,
Model 300 (X840.87)
Gift of Prime Computer Corporation

Research Machines, Ltd.,
380Z (X810.87)
Gift of Research Machines Ltd.

Scientific Data Systems,
SDS 940 Computer (X630.85)
Gift of Systems Concepts, Inc.

Synertek Systems Corporation,
SYM-1 (X804.87)
Gift of Robert Perlstein

Xerox Corporation,
Alto II (X749.86)
Gift of Xerox Corporation

Subassemblies and Components

Atari, Inc.
PONG Game Board (X833.87)
Gift of Alan Rifkin

Data General Corporation,
MicroNOVA CPU Unit (X634.85)
Gift of Data General Corporation

Digital Equipment Corporation,
Pre-PDP-1 Circuit Boards (X760.86 A-N)
Gift of David Spicer

Digital Equipment Corporation,
VAX 785 Processor Board (X759.86)
Gift of Digital Equipment Corporation

General Electric Company,
GE-235 Bay and Console (X798.86)
Gift of Harry David

International Business Machines Corporation,
IBM 7094 Console (X837.87)
Gift of George Sadowsky

Lewyt,
Printed Circuit Boards (CM-100 and CM-559) (X825.87)
Gift of Meshna Electronics

MIT Artificial Intelligence Laboratory,
CONS Machine Wire-Wrapped Backplane (X841.87)
Gift of MIT Artificial Intelligence Laboratory

Remington Rand,
UNIVAC I Boards (X828.87)
Gift of John D. Recob

Remington Rand,
UNIVAC 1200 Series Modules (X797.86)
Gift of Joel M. Goldberg

Sylvania Electric Products, Inc.,
Semiconductor Diode (X812.87)

Power Transistor (X813.87)
Gift of Frank Flynn

Memories

Digital Equipment Corp.,
PDP-8 Core Memory (X793.86)
Gift of Stanley Reich

Electromagnetic Memories, Inc.,
Core Memory Unit (X652.86)
Gift of Ralph Graves

Electronic Memories, Inc.,
Core Stack Module (X647.85)
Gift of Boudreau Computer Services

Fabri-Tek, Inc.,
Core Memory Module (X646.85)
Gift of Boudreau Computer Services

Fabri-Tek, Inc.,
Fabri-Tek Core Memory Stack (X632.85)
Gift of Systems Concepts, Inc.

Ferroxcube Corporation of America,
DDP 116 Core Memory Stack (X645.85)
Gift of Boudreau Computer Services

Ferroxcube Corporation of America,
Core Memory Stack (X631.85)
Gift of Systems Concepts, Inc.

Honeywell, Inc.,
Datamatic 1000 Magnetic Tape (X660.86)
Gift of Honeywell Information Systems

International Business Machines Corporation,
Disc Drive (X758.86)
Gift of Thomas Zucker-Scharff

International Business Machines Corporation,
IBM 1360 Photodigital Storage System (X789.86)
Gift of Lawrence Berkeley Laboratory

CDC 1604, 1960. The 1604 was CDC's first mainframe computer. Designed by a team led by Seymour Cray, it had a 48-bit word and the purchase price with 32K of core memory was $990,000. It used paper tape input and output that operated at 350 characters per second. In addition, four magnetic tape subsystems were available for $145,000 each. By 1961, CDC produced one 1604 each month.

The first system was installed at The Naval Postgraduate School, Monterey, California. It was used for weather prediction, simulation, data processing, and games (for business, industry, and the military).

The Computer Museum acquired a complete 1604 that had been in service at the University of Illinois. When it was shut down, Jim Payne, one of its operators, saved the machine in working order. He put it in his parents home and dreamed of bringing the 1604 back to life as his retirement project. When this became unfeasible, Jim called us to come to his rescue and save the last known 1604. About the same time we heard of a museum project underway at Cray Research in Chippewa Falls, Wisconsin. We accepted the computer and immediately loaned it to Cray Research. If plans move along a complete, operable CDC 1604 will be on exhibit in Chippewa Falls.

International Business Machines Corporation,
2135 Disc Cartridge (X761.86)
Gift of Northgate Construction Company, Inc.

Lytton Industries,
Core Stack (X644.85)
Gift of Boudreau Computer Services

National Bureau of Standards,
SWAC Williams Tube (X625.85)
Gift of Jerry Mendelson

Raytheon Company,
Biax Nanolok Core Memory (X635.85)
Gift of James Sutherland

Remington Rand,
UNIVAC Core Memory Board (X826.87)
Gift of Meshna Electronics

Remington Rand,
UNIVAC Magnetic Tapes (X831.87)
Gift of John D. Recob

Remington Rand,
UNIVAC 9300 Plated Wire Memory (X784.86)
Gift of Vanguard Recording Society, Inc.

Vermont Research,
Drum Unit (X786.86)
Gift of Carl Mikkelsen

Vermont Research,
Model 104S Drum Unit (X788.86)
Gift of Robert Kershaw

Unknown,
Magnetic Shift Registers (X801.86)
Gift of Charles Crocker

Unknown,
Prototype Core Memory System (X827.87)
Gift of Meshna Electronics

Unknown,
Rope Memory Board (X830.87)
Gift of John D. Recob

Calculating Devices

American Can Company,
American Adding Machine (X619.85)
Gift of Mr. and Mrs. Charles Collazzo

Bowmar Instrument Corporation,
Model No. 90505 (X753.86)
Craig Model 4501A (X754.86)
Gift of Bowmar Instrument Corporation

Brunsviga Maschinenwerke Grimm, Natalis & Company,
Brunsviga 20 (X762.86)
Gift of Murlan S. Corrington

Burroughs Corporation,
Visible Adding and Listing Machine (X671.86)
Gift of Charles Sumner, Inc.

Commodore Business Machines, Inc.,
1121 Calculator (X663.86)
Gift of Baynes Electric Supply Company

Curta,
Curta Calculator (X816.87)
Gift of David Thorndike

Friden Corporation,
Model 130 Calculator (X732.86)
Model 132 Calculator (X733.86)
Gift of James Patton

Hewlett-Packard Company,
HP-12C (X768.86), HP-41C (X769.86), HP-71B (X770.86),
HP-35 (X771.86), HP-28C (X805.87)
Gift of Hewlett Packard

Hewlett-Packard Company,
HP-65 (X752.86)
Gift of Darwin Smith

Hewlett-Packard Company,
HP-25 (X736.86)
Gift of William Herman

International Business Machines Corporation,
Hexadecimal Adder (X803.87)
Gift of C F S Inc.

London Computator Corporation, Ltd.,
Model LC/509/S/1598 Computator (X650.86)
Gift of Gordon and Gwen Bell

Marchant Calculating Machine Company, Inc.,
The Marchant (X779.86)
Gift of A. Peter Hollis

Mini-Add, Inc.,
EXACTUS (X649.86)
Gift of Gordon and Gwen Bell

MIT RDA,
#2 Differential Analyser Component (X838.87)
Gift of Richard W. Hamming

Monroe,
1860 Statistical Programmable Printing Calculator (X802.86)
Gift of Peter Livingston

Monroe,
EPIC 2000 (X764.86)
Gift of Alan Chinnock

Monroe,
Model 1665 Programmable Calculator (X765.86)
Gift of Richard S. Murdock

Monroe,
Rotary Calculator (X796.86)
Gift of Charles H. Gushee

Norden,
Bombsight (X809.87)
Gift of Mark Burnham and Steve Gamelin

North American Aviation, Inc.,
Nuclear Weapon Effects Probability of Destruction Calculator (X677.86)
Gift of David Martz

PERRYGRAF,
Harvard Project Physics Multiplication/Division Circular Slide Rule (X621.85)
Gift of I.B. Cohen

Pickett & Eckel, Inc.,
Model N4T Vector Type LOG LOG Dual-Base Speed Rule (X659.86)
Gift of Rich Simon

Selectronics, Inc.,
PD-10 Personal Directory (X756.86)
Ultradial 120 (X757.86)
Gift of Selectronics, Inc.

Sharp,
Elsi Mate EL-8130 (X766.86)
Gift of Gregory Welch

Sinclair Radionics, Ltd.,
Scientific Calculator Kit (X824.87)
Gift of Jim Kistler

Sinclair Radionics, Ltd.,
Sovereign Calculator (X654.86)
Gift of Brian Randell

Sony Corporation,
SOBAX-2700 (X745.86)
Gift of Maccabees Mutual Life Insurance Company

Texas Instruments,
TI Programmable 57 (X767.86)
Gift of Gregory Welch

The Lovelace Biomedical and Environmental Research Institute, Inc.,
Nuclear Bomb Effects Computer (X856.87)
Gift of Steve Golson

Triumphator-Werk,
Triumphator (X776.86)
Gift of Victor H. Deutsch

Wang Industries, Inc.,
Electronic Calculator Model 320 (X815.87)
Gift of Joseph Sears

Unknown,
Circular Slide Rules (X794.86), (X795.86)
Gift of Richard S. Murdock

Unknown,
Soumatic Circular Slide Rule (X622.85)
Gift of I.B. Cohen

Transducers

Alphacom Inc.,
VP42 Printer (X774.86)
Gift of Thomas Restivo

American Automatic Typewriter Company,
Model 6300 Auto-typist (X782.86)
Gift of Arnold J. Utstein

Anadex, Inc.,
Model DP-8000 Printer (X628.85)
Gift of Computerland, Inc.

AT & T Bell Laboratories,
Prototype Nixie Tube (X672.86)
Gift of David Hagelbarger

Canon U.S.A., Inc.,
Laser Beam Printer LBP-10 (X857.87)
Gift of Canon U.S.A., Inc.

Centronics Data Computer Corporation,
Model 730-1 Printer (X627.85)
Gift of Computerland, Inc.

Centronics Data Computer Corporation,
Microprinter-S1 (X775.86)
Gift of Murray Melbin

Computone Systems, Inc.,
Keypact Micro-VIP (X780.86)
Gift of Leonard M. Coris

Control Data Corporation,
Programmed Film System (X664.86)
Gift of J. Stanley Hill

Digital Equipment Corporation,
PDP-9 Scope (X783.86)
Gift of Donald Tufts

Friden,
Justowriter (X811.87)
Gift of Wayne Thomsen

Hazeltine Corporation,
2000 Terminal (X668.86)
Gift of Carroll School For The Blind

International Business Machines Corporation,
Port-A-Punch (X620.85)
Gift of Kirtland Olsen

International Communications Corporation,
40 + 10 Printer (X636.85)
Gift of Geoffrey B. Larkin

Kleinschmidt Division of Smith Corona Marchant,
Teletypewriter TT 227/FG Reperforator/Transmitter-Distributor (X656.86)
Gift of Michael S. Drooker

Motorola, Inc.,
MDR Optical Card Reader (X737.86)
Gift of George P. Leyland

National Multiplex Corp.,
Digital Data Recorder Cartridge Drives (X738.86)
Gift of George P. Leyland

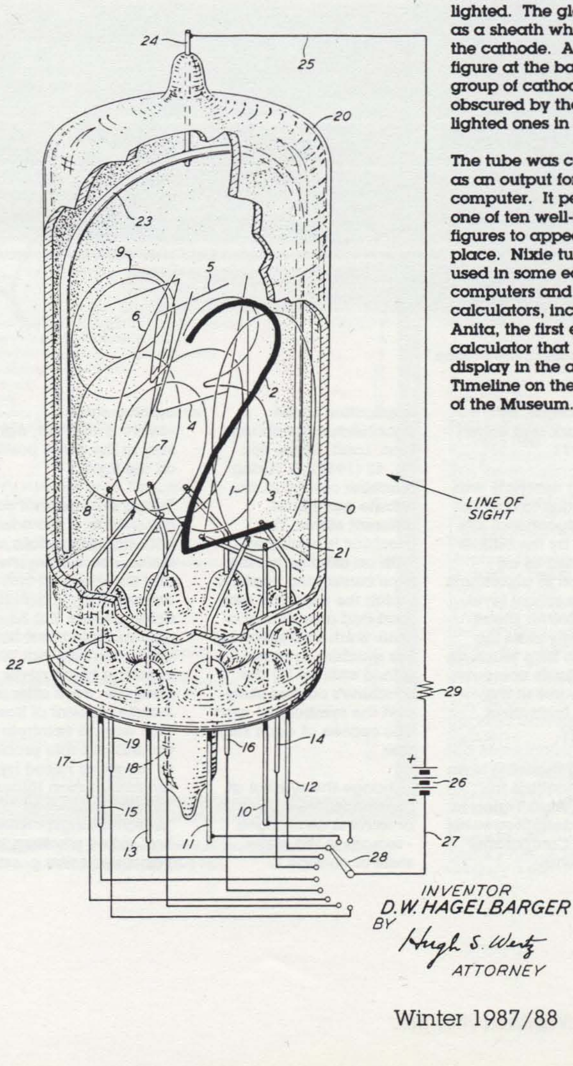
Owens Glass,
University of Illinois Plato IV Terminal Plasma Display Panel (X676.86)
Gift of Joseph Cychosz

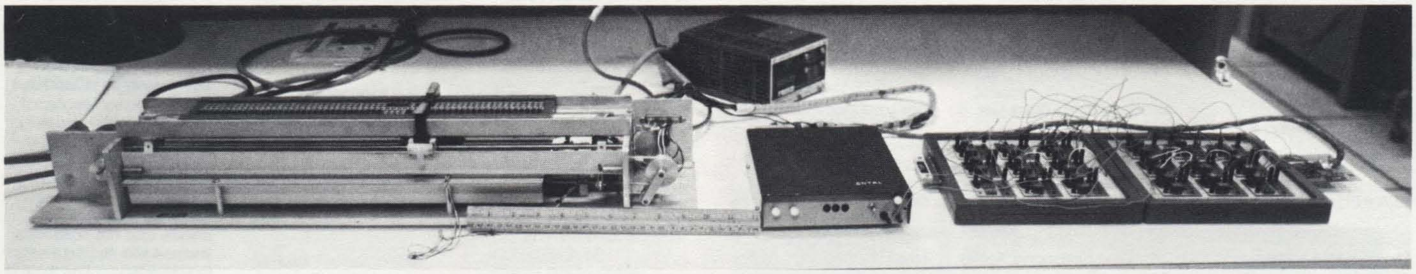
Rand Corporation,
Prototype Videographics Terminal (X653.86)
Gift of Rand Corporation

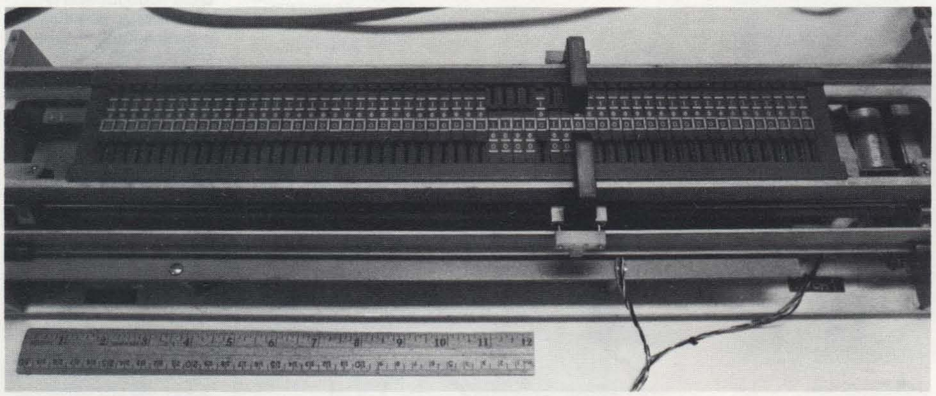
Raytheon Company,
DIDS-400 (X657.86)
Gift of David Ahl

Patent drawing for Prototype Nixie Tube, A T & T Bell Laboratories. The prototype Nixie Tube and the patent material were presented to the Museum by its inventor, David Hagelbarger. This is a glow discharge tube for displaying numbers. The tube contains an anode and ten cathodes shaped like the figures 0 to 9 inclusive. The tube is filled with gas and a glow discharge initiated between the anode and cathode that is to be lighted. The glow occurs as a sheath which covers the cathode. A glowing figure at the back of a group of cathodes is not obscured by the unlighted ones in front of it.

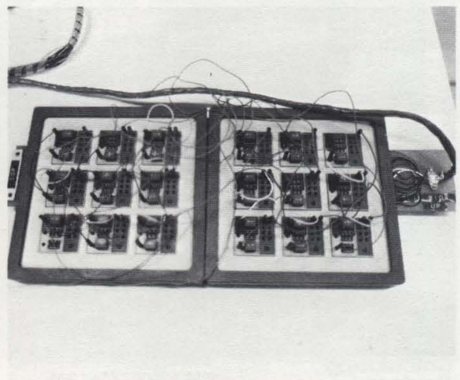
The tube was conceived as an output for a computer. It permits any one of ten well-formed figures to appear in one place. Nixie tubes were used in some early computers and calculators, including the Anita, the first electronic calculator that is on display in the artifact Timeline on the fifth floor of the Museum.







The Turing machine's "tape."



Patch panels representing up to eighteen states.

Turing Machine, by Wesley Clark and Robert Arnzen, 1971

This Turing machine was a contribution to a workshop on educational kits sponsored by the IEEE. It was intended as an introduction to algorithms at the high school level. Professor Carver Mead subsequently used the machine to help teach an undergraduate computer science course at the California Institute of Technology.

The Turing machine is an abstract machine invented by Alan Turing in 1935 and described in his paper 'On Computable Numbers with application to the Entscheidungsproblem.', Proc. Lond. Math. Soc. (2), 42 (1937). A Turing machine can be in one of a finite number of different states. The machine is equipped with an arbitrarily long tape containing symbols which the machine can read and alter one at a time. Each step taken by the machine is determined entirely by the machine's current state and the symbol just read. The options at each step are:

- change the symbol at the current tape position or leave it unchanged
- remain in the same state or change to another state
- move a step left, right or stay in the same position on the tape.

Turing showed that such a machine, if provided with an appropriate set of states, could compute any number that can be arrived at by a definite, finite process. But he also demonstrated that there were numbers that his machine could never compute, even after an infinite amount of time. This was an example of an undecidable problem in the sense raised by the mathematician Hilbert. Hilbert's renowned 'Entscheidungsproblem' had asked whether, in principle, it was possible to decide whether a mathematical assertion was true or false. The Turing machine showed that the answer was 'no.' In addition, Turing showed how such a machine was universal; it could, if provided with the appropriate table of states, simulate any other machine.

In this realization, the tape consists of 59 sliders each element of which can be in one of three positions: one, zero, or blank. The machine reads the tape by means of a pair of light beams and photodetectors and writes by moving the sliders with an electromagnet. The machine's states are represented by the squares on patch panel boards; two boards offer up to 18 distinct states. The three outputs of the state (depending on whether the current tape value is 1, 0, or blank) are on the left. At each step, the machine transfers to the state connected to the activated output. Immediately to the right of each output is the corresponding program step for that state. This is implemented by plastic plugs of two types: arrows to move left or right on the tape and crossed arrows that flip the current tape value before moving. The inputs to the state are on the right side of the state's square.

Students were set problems such as constructing a program that counts in binary using only two states. It takes just a few moments to implement a program using the pluggable wires and program step keys. To help with debugging, the machine can single step through a program. In run mode it executes at a rate of about one state a second. The machine endows its programs with a tangible reality; lights come on as each state is entered, and a loud click is heard whenever the tape is altered.

Rx Systems, Inc.,
Rx Terminal (X662.86)
Gift of Herbert Teager

Science Accessories Corporation,
Sonic Digitizer (X742.86)
Gift of George P. Leyland

Tabulating Machine Company,
Key Punch (X791.86)
Verifier (X792.86)
Gift of Stanley H. Richards, Jr.

Xerox Corporation,
Dover Laser Printer (X750.86)
Gift of Xerox Corporation

Robots

Carnegie Mellon University Robotics Institute,
Direct Drive Arm I (X822.87)
Gift of Carnegie Mellon University

Carnegie Mellon University Robotics Institute,
Pluto, CMU Rover (X823.87)
Gift of Carnegie Mellon University Robotics Institute

Denning Mobile Robotics, Inc.,
Sentry (X819.87)
Gift of Denning Mobile Robotics, Inc.

General Motors,
Materials from Consight-I Project, including Robot Arm, Conveyer Belt, and Structured Light Assembly (X820.87)
Gift of General Motors Research Laboratories

International Robomation/Intelligence,
IRI-M50 (X817.87)
Gift of Advanced Technology Systems

Johns Hopkins University, Adaptive Machines Group,
Beast (X821.87)
Gift of Johns Hopkins University

Naval Systems International, a joint venture of Deep Sea Systems and Benthos Inc.,
Sea Rover (X818.87)
Gift of Naval Systems International

Rehabilitation Institute of Pittsburgh,
Page Turning Robot (X844.87), Prototype (X843.87)
Gift of Rehabilitation Institute of Pittsburgh

Robotics Systems International Ltd.,
The Spider, from the movie, "Runaway" (X845.87)
Gift of Robotics Systems International Ltd.

Tomy Kyogo Company,
Omnibot 2000 (X846.87)
Gift of Raymond Industries

Miscellaneous Artifacts

AT & T Bell Laboratories,
CARDIAC: A CARDboard Illustrative Aid to Computation, The Information Machine (X674.86)
Gift of David Hagelbarger

Bally Manufacturing Corporation,
Computer System (aka Bally Astrocade) (X726.86)
Gift of Michael Walter

Binary Arts Corporation,
Hexadecimal Puzzle (X618.85)
Gift of Binary Arts Corporation

Cite Sciences et Industrie,
Smart Security/Credit Card (X617.85)
Gift of Gerard Courtieux

Wesley Clark and Robert Arnzen,
Electro-mechanical Turing Machine (X641.85)
Gift of Carver Mead

Donald Lancaster,
Prototypes, Function Generator (X728.86), Electronic Stopwatch (X729.86), DigitalVoltmeter (X730.86), Pitch Reference (X731.86)
Gift of Donald Lancaster

Edu-Cards Corporation,
DIGI-COMP 1 (X638.85)
Gift of Jules Corn

Magnavox,
Odyssey (X808.87)
Gift of Tom Johnson

Natural MicroSystems Corporation,
WATSON, (648.85)
Gift of Natural MicroSystems Corporation

David Ahl, the creator and editor of *Creative Computing*, a magazine that he started in his garage in 1975, gave the Museum his entire collection of journals. It includes full sets of many of the smaller circulation and early specialized magazines that characterized the beginning of personal computing.

NCR,
PhotoChromic Micro-Image (X829.87)
Gift of John D. Recob

Oliver Audio Engineering,
OP-80A Paper Tape Reader, Data-Link, Inc., Paper Tape Splicer, Time Sharing Applications, Inc., Paper Tape Rewinder (X740.86 A-C)
Gift of Alan E. Frisbie

Oliver Garfield Company,
ENIAC Electric Brain Construction Kit (X734.86)
Gift of Thaddeus M. Hershey

Oliver Garfield Company,
GENIAC (X836.87)
Gift of Elliot Linzer

Playskool, Inc., A Milton Bradley Company,
Play & Learn Computer (X741.86)
Gift of Michael Seidenman

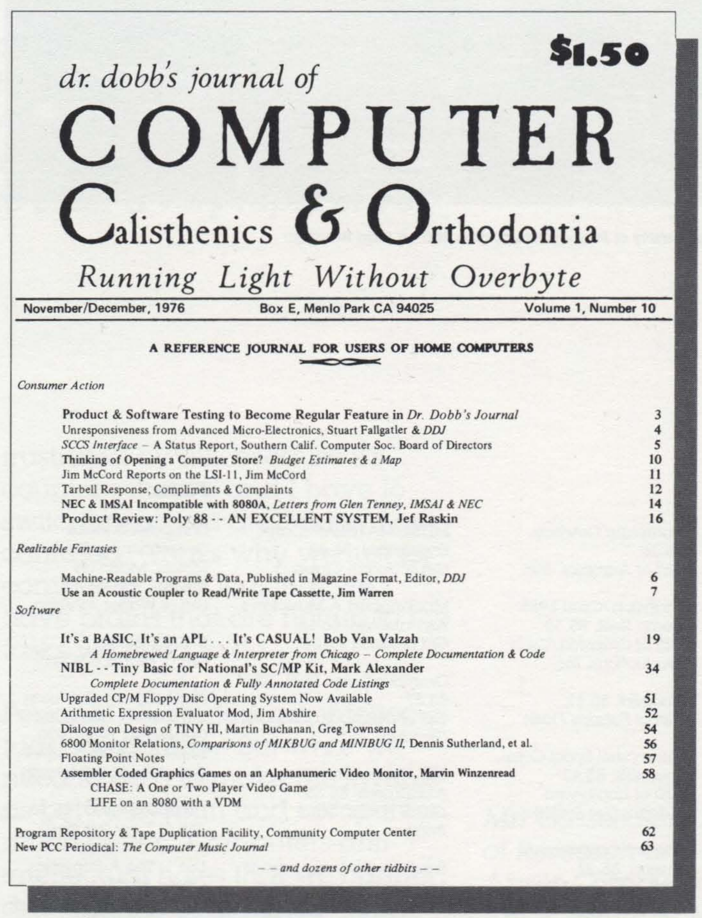
Radio Shack,
Mathmile Computer (X814.87)
Gift of G. Wilcox

Science Fair, Inc.,
Analog Computer (X744.86)
Gift of Steven A. Carpenter

Scientific Development Corporation,
Minivac 601 (X743.86)
Gift of John Van Devender

Unisonic Products Corporation,
Tournament T102 Sportsman (X746.86)
Gift of Shirley M. Sinn

Wm. Schollhorn Company,
Punch Card Hole Puncher (X658.86)
Gift of Kevin Dearne


$1.50

dr. dobb's journal of

COMPUTER
Calisthenics & Orthodontia

Running Light Without Overbyte

November/December, 1976 | Box E, Menlo Park CA 94025 | Volume 1, Number 10

A REFERENCE JOURNAL FOR USERS OF HOME COMPUTERS

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Dr. Dobb's Journal of Computer Calisthenics & Orthodontia, November/December 1976. From the David Ahl Collection of Periodicals: 1975-1985

Manuals, documentation, periodicals, references, proceedings, and books have been received from the following donors. Projects are underway to catalogue these items.

David H. Ahl
Stewart Alsop
Alex M. Andrew
Antics Enterprises
Artronics, Inc.
ASCII Corporation
Donald S. Berman
Microsoft, Inc.
Bitstream, Inc.
R. T. Bradshaw
Chris Burns
Margaret Butler
California Institute of Technology
Paul Ceruzzi
Judith Clapp
Ernest B. Cohen
Roger Cole
Richard J. Conlan
Robert J. Cowen
Cranston/Csuri Productions, Inc.
Frank Crow
Dahner-Hayes,Inc.
Bill Dobson
Philip H. Dorn
Peter B. Dunckel
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General Motors Corp.
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Paul D. Lehrman
Robert E. Machol
MAGI
Nelson Max
Donald McIlroy
Tim McNeill
Howard Mead
George Michael
MITRE Corporation in memory of David James
Phillip Mittelman
Manfred Mohr
Gregory E. Moore
Stephen Munier
National Decision Systems
P. D. Neuhauser and Jet Propulsion Laboratory
Omnibus Computer Graphics, Inc.
Pacific Data Images
George Peo
Powersharing Inc.
PPG Industries
David Price
Tony Pritchett
Raytheon Company
John D. Recob
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Xerox PARC
Xerox PARC/CSL & ACM
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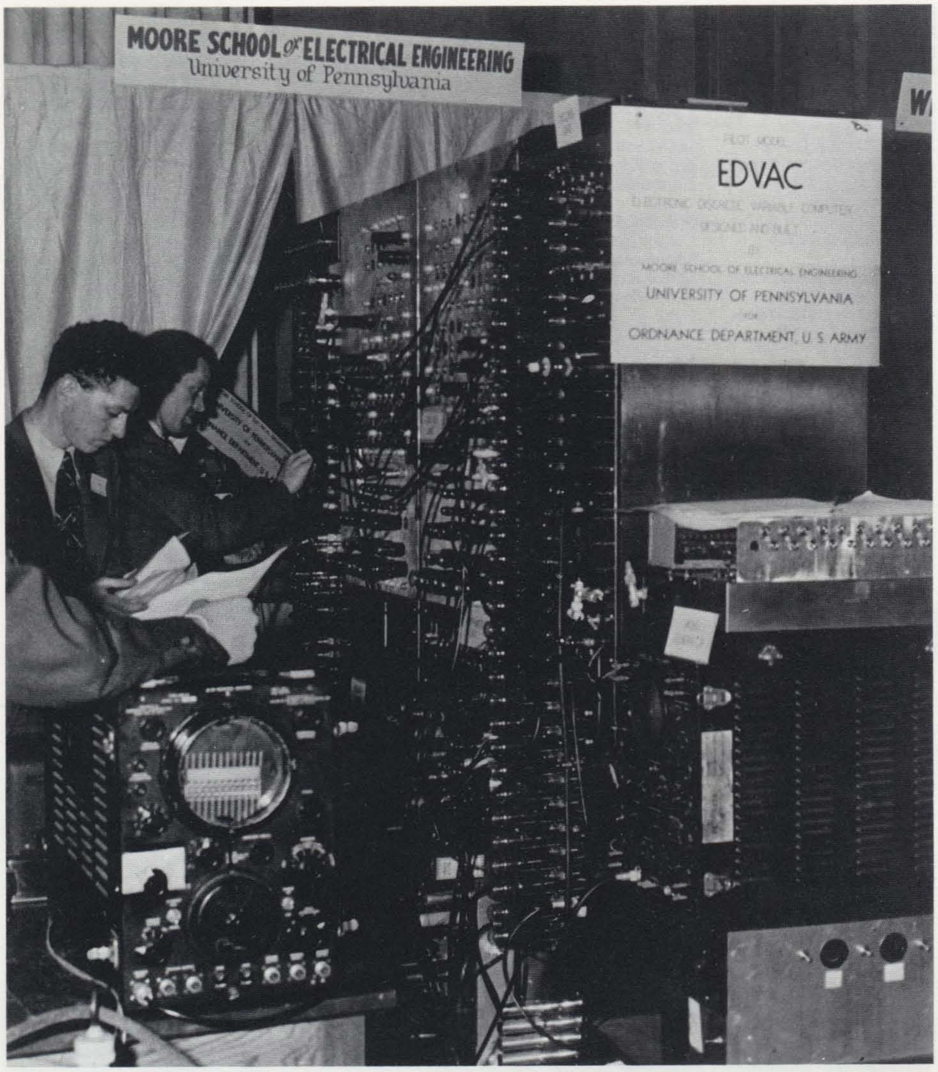


Photograph of the EDVAC, University of Pennsylvania, donated by Sam Berman.

This is an early photograph of the EDVAC, the physical manifestation of the computer outlined in the "Draft Report" produced by John von Neumann in 1945. The plans for EDVAC were widely publicized and were the main topic of an influential series of lectures given at the Moore School in 1946. However, the original team of Presper Eckert, John Mauchley, John von Neumann, Herman Goldstine and others broke up during the building of the EDVAC. This picture dates from about 1949, when it was completed at the Moore School of Electrical Engineering. It was delivered to the Ballistic Research Laboratory later that year. After further developments the EDVAC became operational in 1951 and continued in use until 1962.

Software

Visicalc Software and "Software Arts Auction" notice, 87.67
Gift of Robert C. Gray

RECOMP II Computer Documentation and Punched Paper Tape Software, 86.40
Gift of Alan I. Friedman

Videotapes

ACM Conference on the History of Personal Workstations, 87.63
Gift of Xerox PARC/CSL and ACM

Antics Computer Graphics Demo '85, 85.43
Gift of Antics Enterprises

Argonne National Labs and University of Illinois films of Pioneer's Day, 86.43
Gift of Margaret Butler

Computer Cowboy, 85.36
Gift of Artronics, Inc.

Cranston/Csuri 1985 Demo Reel, 85.38
Gift of Cranston/Csuri Productions, Inc.

Hackers, 85.41
Gift of Fabrice Florin

Honeywell Spoof Commercials, 85.42
Gift of Honeywell Information Systems

Inertial Confinement Fusion, 85.27
Gift of Nelson Max

Konrad Zuse Interview on NDR (German Television), 86.22
Gift of Paul Ceruzzi

MAGI Demo Reel 1985, 85.34
Gift of MAGI

MITRE MATHLAB (Carl Engelman), 86.42
Gift of Judith Clapp

Mockingbird A Musician's Amenuensis, 86.16
Gift of Xerox PARC

Omnibus Demo Reel, '85, 85.37
Gift of Omnibus Computer Graphics, Inc.

PDI Animation Assortment, 85.35
Gift of Pacific Data Images

Songs in the Language of Information, Installation of March 1985 Sarah Greitz Exhibition at MIT, 85.25
Gift of Sarah Greitz

The Mechanical Universe, 85.39
Gift of California Institute of Technology

Films

Computer Surface Generation by Ford Motors, Made on the IBM 704, 86.13
Gift of Walter Johnson

EDSAC, 86.31
Gift of Maurice Wilkes

First Magi-Synthavision Demo Reel, Computer Generated 1968-1970, Word Processing, 85.49
Gift of Phillip Mittelman

Flexipeed, 1967, 85.26
Gift of Tony Pritchett

Leo 1, The Automatic Office, 87.62
Gift of International Computers Limited

Project Mac, 87.64
Gift of Charles W. Therrien

UNIVAC Sales Presentation, 86.11
Gift of PPG Industries

Photographs

First GTE Computer Printed Telephone Bill (photocopy), 87.77
Gift of GTE Data Services, Inc.

Mariner IV Data (color negative), 87.69
Gift of P. D. Neuhauser and Jet Propulsion Laboratory

Martin Newell's Teapot Images, 87.61;
Gift of Frank Crow

EDVAC (3), 85.44
Gift of Donald S. Berman

National Computer Conference 1985 photographs from Pioneer Day Exhibit (approx. 175 photos)
Gift of Margaret Butler

Ephemera

Computer Buttons (X763.86)
Gift of David Corbishley

ComputerWorld Button Collection (X858.87)
Gift of Jack Edmonton

CCC tietack (X847.87), DEP-316 Tile (X848.87), The Pulse, Framed Copies (X850.87)
Gift of Edward McManus

DEUCE Programmers Reference Card & 3 Punch Cards (X851.87)
Gift of Peter Clout

Honeywell Animal Poster, "Forget-Me-Not Computer Brochure, and Honeywell D1000 Computer Brochure (X852.87)
Gift of Honeywell Information Systems, Inc.

Honeywell Animals Playing Cards in Binary Notation (X853.87)
Gift of Roberto Canapa

John D. Recob Collection of Computer Ephemera (X832.87)
Gift of John D. Recob

OPM Bookmark (X854.87)
Gift of Philip H. Dorn

Temporary Pass for Admittance to SAGE North Bay Canada Installation (X855.87)
Gift of David Scully

Treni, Inc., TRENI III Mascot Computer and 'No-op Software' Punch Card Confetti (X623.85)
Gift of Robert E. Youngberg

The Future of Personal Computers

Jean-Louis Gassée

Henri Bergson, in the early part of the twentieth century, stated: "Intelligence, in what seems to be its original feature, is the faculty of manufacturing artificial objects, especially tools for making tools." This is a very nice representation of personal computers long before they were created. But it shows that the computer, as a tool, has been desired for a long time.

This is only the beginning of the beginning. For all intents and purposes, what has happened until now can be dismissed. A couple of years ago, people questioned whether there were fewer technical innovations and the personal computer industry was slowing down. I don't even see that we are at the shoulder of a curve that is flattening out; we are about to enter a very rapid era of evolution.

What are personal computers today?

Personal computers are tools that will bring about a greater cultural change than Guttenberg, TV, or even air conditioning. The crux of the matter is that mankind has been in a long continuous developmental effort to make things that our brains don't do well. Our power of reasoning is very effective but not very efficient. We are great at seeing patterns — great at isomorphism — finding knobs and twisting them conceptually. But we can't do sums; we're miserable at arithmetic. While I'm a mathematician by trade, I have great difficulty in translating miles per gallon to liters per kilometer. I'm frustrated by this because it's counter-intuitive and I have to switch measures and units. I get confused. That's why we lust for computers. We feel that we have brains that are not up to the tasks we need to do.

Personal computers are intellectual power tools. But what we need to do is to make the symbiosis between man and computer much better. Computers drill intellectual holes that we cannot drill with our own minds. They are simulating engines and new media. The electronic spreadsheet is a simulation of an existing environment with lines and

Mr. Gassée, Senior Vice President of Research and Development, Apple Computer, Inc., spoke at the Museum in May 1987. This is an edited transcription of his talk. The Computer Museum is responsible for any inaccuracies it may contain.

columns; it is an enriched electronic metaphor of an existing situation. On the other hand, each time the electronic metaphor is impoverished it doesn't work, such as most applications of "home computing" with the poor metaphor of the cookbook or checkbook.

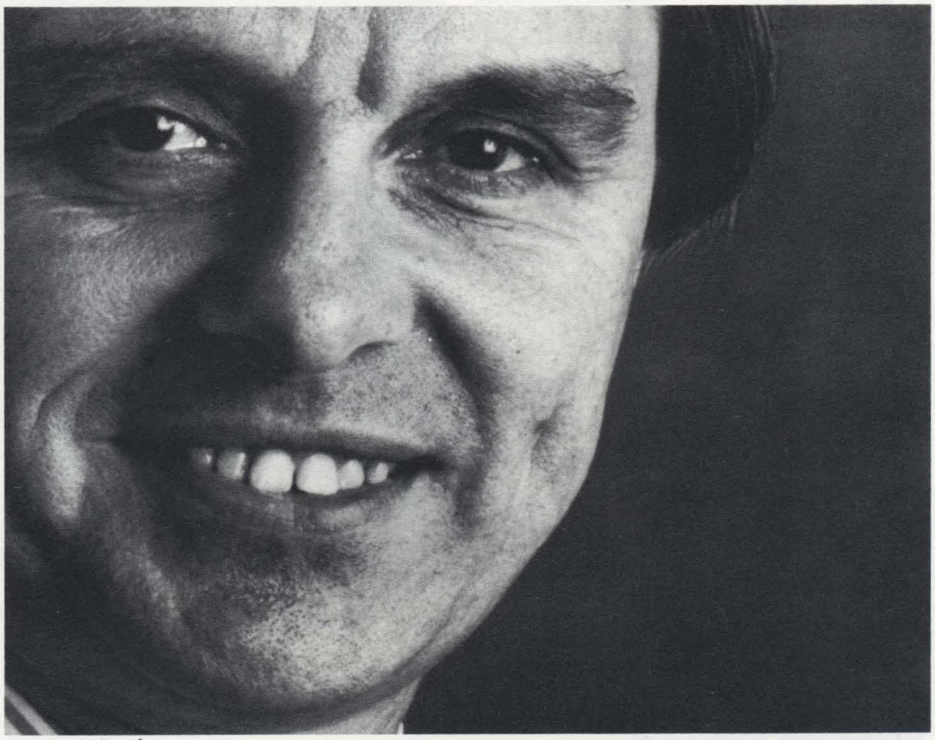
Why is the personal computing simulation engine a good tool? The human being has a lot more power to implement design decisions using a personal computer, whether it is designing a memorandum on a good word processor, preparing slides with a great outliner or desk-top publishing program, or designing mechanical or electrical objects.

Personal computers are not large computers made smaller. For example, financial planning was done on mainframes long before the TRS-80 or VisiCalc. Information was fed into the computer, it crunched away, and later excreted the results. The TRS-80, Commodore 64, the Apple II, and VisiCalc marked the birth of personal computers for real people, not just for hackers. The difference between financial calculation on a mainframe and on VisiCalc is clear. On the personal computer everything happens right now. It is an interactive simulation; not input, processing, and then output.

The Short Term Future

Contrary to some past predictions, technology is accelerating. In the next five years, we will see greater improvements in silicon, magnetics, printing, and network devices (but not keyboards) than in the past five years. Since 1978, personal computers have cost $5,000 and each generation has brought much more power. The next round will have much better, deeper graphic capabilities at this same cost. This phenomenon will continue into the future.

The short term will also see more players. Several years ago, the compression of the industry was predicted. But today, there are more semi-conductor companies, more software companies, and more vendors of all kinds. And, we haven't seen our friends from Japan in the marketplace yet. The only conclusion is that there will be more players and not less players.



Jean-Louis Gassée

Courtesy of Apple Computer

The Intermediate Future

Quantity begets nature; by this I mean that when the population grows, the use changes. It is not just the number of MIPS that are available, but how they are managed for the user. We hope to see rapid evolution of user interfaces.

The intermediate term change will be real networking. Today it is not affordable by most, and when it is used the user is too network conscious. The real purpose of a network is to disappear. It is a means to an end for shuttling data back and forth. The real change is that data will be more compatible across vendor lines so that you won't have to worry about which brand of computer you use to develop your spreadsheet and which brand you use to create your graphics and printing.

It is important to have standards for the substrate of data and networks so that user-interfaces and computers can be diverse. The big fuel for growth will be invisible, heterogeneous networking.

Having a computer that has access to remote memory without going through protocols will make them more intelligent. This phenomenon will not occur in the short term because of the slow development of ISDN "Integrated Services Digital Network."

With networks you can have such a new product as an integrated network spreadsheet. For example, you can call in data to your spreadsheet from other computers on the system and other spreadsheets can be updated as information is changed. Peer-to-peer communication will create greater productivity.

The More Distant Future

Long term predictions also relate to interactive simulations. Imagine that you can sit in front of your computer and plan a trip to Italy. Today, you would have to get into Dow Jones or CompuServe and then into the Official Airline Guide and start muddling in schedules. It's painstaking and requires a lot of knowledge. Normal people cannot do it. And in this industry, we have to serve normal people, not people with lots of money or who like to "hack." Now let's imagine that you can invoke a map of Italy and point where you want to go. The computer proposes schedules, shows you pictures of hotels, museums, restaurants, beaches, and other places of interest so that you can simulate your trip. Try it conceptually and find out what it's going to cost. If it's too much, then you can try something different. And then when satisfied, make the reservations. It's not hard to imagine that you would like to do that.

Similarly, if you want to remodel your house, it would be nice if your computer knew a lot about its structure, the building codes, the wiring, etc. Then you could go through an aided-simulation of changing the family room so that you don't have to draw the plan. The computer does this and then follows through with costing, scheduling, and the other planning processes in remodeling.

Computers today, although we love them, are hopelessly underpowered. To do those kinds of simulations, our computers are several orders of magnitude underpowered. We need new ways to use the greater power that is very easy for us. We need A.I. and A.I., A.I., A.I. . . . . in ways that I can't even specify today.

Today there are 10,000 data bases that are available. That is nice? Maybe? If I say "Honda Civic" to you, we share a common enough data base that we know what this means. We can have a meaningful dialogue about it. But I have no cognitive experience about what 10,000 data bases mean. It is hard enough to dial into Dialog. Most data bases are unusable. They require navigation tools. We can only hope that ISDN will be equalized networking technology to the home and the office. We need real door handles to make it useful for everyone. We still don't have the VisiCalc of data bases.

"Having a new language, we will have new thoughts."

Another longterm goal is to provide a symbiotic relationship between man and computer. People at MIT, Xerox PARC, and then Apple promoted the mouse. What is it? It is not meant to replace the keyboard; when you want to type text you type text. The mouse provides direct manipulation with the computer. For instance, instead of typing delete "such and such file," you simply grab the mouse and throw the file in the trash can. You do it directly. You don't have to know how to spell. You just do it.

Some ideas, derived from the devices to help the disabled use computers, take us beyond the mouse. There are prostheses that capture nervous system outputs and convert them into simple computer commands. Neurophysiologists have known that when we read we unconsciously send commands to the larynx. We don't speak out loud because we are told (after we learn to read) that we have to shut up. So we shut up, but the brain keeps sending the signals and we learn to control the impulse to speak, almost. Most people still do little jittery movements of the larynx as they read.

In the symbiosis between man and computer, the impulses in the nervous system can be decoded for direct manipulation of the computer without having to grab the mouse with our hand. This is technologically not necessarily any more difficult than understanding speech, especially in only controlling a small set of actions such as moving cursors and clicking mice. This is fallout from the work being done with fighter pilots for control in the cockpit. My dream is for gestural or neural input and graphic output. If you look at a neural physiological map of the neurons in the cortex you will find that the hand has the most territory.

McLuhan said, "Man forges tools and thereafter our tools shape us." This new medium, the computer, will create new thoughts. That sounds bizarre. If we have computers that communicate with the nervous system we will think, learn, and play differently . Having a new language, we will have new thoughts.

Computers today are exceedingly difficult to program. With new, more powerful machines, we will sacrifice a little of the new speed to have easier programming. Today the marketplace is screaming for user-controlled languages because people want control. People want power. Do you like to program your VCR? The coffee maker?

The Great Equalizer

My concerns for the future include the creation of the gulf between the computer haves and the have nots. The gap between the most and least educated persons in the Western world is widening. We are in great danger of creating an intellectual South Africa. The people with the best education end up with the most interesting, and highest paid jobs. The lack of symmetry is interesting: people who have boring jobs don't get paid more. The most exciting jobs are the best paid.

Apple's Role

Apple stands on the shoulders of giants. We adapt things; we don't invent many things. That's nice. There is nobility in making things nice and usable. Apple's role is to provide platforms for the creativity of other people. Seymour Cray is one of our customers and I'm proud to say he uses our machine to do some drafting. Our role is to integrate ideas and make them into products so that they can be on the shelves in the store for people to buy to enhance their pursuits.

"Learning is not just pouring information into a vessel, the student. Learning is simulation. It is trying out pieces. Putting them together. Trying again."

The great equalizer of having networks in the home and office is going to happen in Europe and Japan before the United States. I don't like it because I want it. (I am a frustrated user.) But I am also frustrated because networks are an important tool for productivity for the whole country. In the US, freeways are built by the federal government. Similarly, I think data freeways should be an edict of the federal government. If this job is not done, the forces of the free market could create a time lag or some expensive incompatibilities that we, as customers, would end up paying for. The ISDN standard for graphic stations is a less attractive subset than the European standards.

While Apple will have a CD ROM device in the future, today's problem is to get two gigabytes of information out of the machine usefully. Experimentation is going on for new navigational devices. We will lick the navigational problem before the publishing problem. Why? We fantasize about using the computer to write. For my next book, I'd like a thesaurus, Strunk and White's *Elements of Style*, and some specialized materials. The data bases that can be on CD ROMs for a mass market are small. I think some vertical market areas may develop, such as tax rules. Nevertheless, Apple will provide a CD ROM product and lose money for a while.

We feel that social policy and long term marketing should be convergent. It should not be a tug of war. But the problem of declining literacy really scares me. If you can't spell, a spelling checker won't do much for you. No one knows how to fix the declining literacy in the Western world. One underlying reason is that technology is making the world easier to live in. The survival needs, just about the poverty level, are less than they used to be. TV is part of this, but it is legal and I don't believe in cultural fascism. VCR's and tapes are the wrong medium for learning. Learning is not pouring information into a vessel, the student. Learning is simulation. It is trying out pieces. Putting them together. Trying again. The reason that there are so few good learning programs on personal computers today is that good learning programs are simulation programs. They are impoverished metaphors of the book or of silly games.

We feel that the computer is the celebration of the human spirit. Holombart, another philosopher, said, "The cathedrals of the twentieth century are cars" because they reflect technology, art, and human freedom. I certainly hope that if Holobart were alive today he would say that computers are the cathedrals of the second half of the twentieth century.

The Early History of LEO: The First Data Processing Computer

John M.M. Pinkerton

John Pinkerton was the chief architect of LEO, which stood for Lyons Electronic Office. LEO, the world's first commercial data processing computer, is a direct descendant of the architecture outlined in draft EDVAC Report via the Maurice Wilkes' EDSAC. LEO I was being used for payroll and office data processing in early 1954, prior to similar use by GE of their UNIVAC 1.

John Pinkerton tells his own story, that of a young physics graduate of Cambridge, who joined The Lyons Company and was inspired by Comptrollers John R.M. Simmons (who died in 1985) and T. Raymond Thompson (who died in 1972) to build the first data processing computer. G.B.

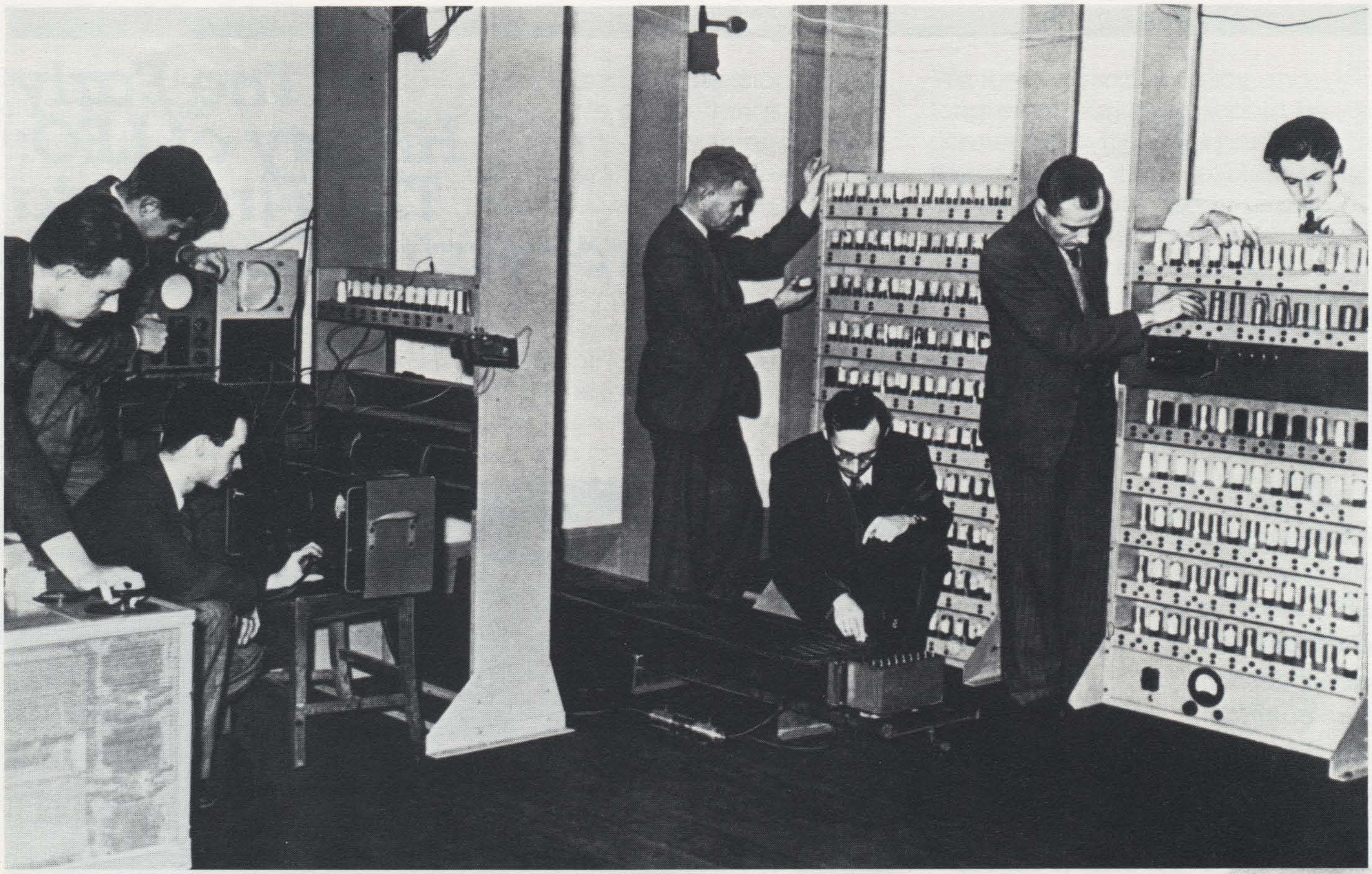
John M. M. Pinkerton and Gwen Bell at the talk. Pinkerton presented the Museum with a marketing film to sell LEO II computers that was made by Lyons in 1957.

This is an abstract of a talk given by John Pinkerton at The Computer Museum on October 4, 1987. A paper on which this talk is based is copyrighted by John M.M. Pinkerton.

The Lyons Company

How did it happen that J. Lyons & Company Limited, a wholesale food and catering business, came to build a computer for its own use and then go into the computer business?

In the 1890s, the Salmon and Gluckstein families started a business at Cadby Hall in West London to cater for functions at the Olympian exhibition halls next door. By the beginning of World War II, Lyons had a high reputation for efficiency with the general public. They ran a variety of wholesale food businesses distributing tea and coffee, ice cream, bread and cakes, as well as other lines throughout the UK. Lyons did not believe in using wholesalers but sold and delivered directly to twenty or thirty thousand small



The EDSAC being built at Cambridge University Mathematical Laboratory. Maurice Wilkes is kneeling in the center behind the mercury delay lines.

retail shops. They also had a chain of about 150 tea shops, four or five large hotels, various restaurants, and an outdoor catering division. They employed 30,000 people. All this meant routine accounting for a vast number of small transactions with clerical efficiency since margins were small.

In the early twenties, the need for effective methods of accounting was recognised and resulted in the recruitment of a young mathematics graduate from Cambridge, John R. M. Simmons. A few years later he recruited another Cambridge mathematician, T. Raymond Thompson. By the mid-thirties they had rationalized the Lyons office practice and brought it under their management. In *LEO and the Managers* (1962), Simmons wrote, "...the curse of routine clerical work is that without exercising the intellect, it demands accuracy and concentration. ...(He was) looking forward to the day when machines would be invented which would be capable of doing all this work automatically."

By the thirties, Simmons and Thompson were not only studying the accounting and calculating machines on the market but using some in intensively unorthodox ways. For instance, they were pioneers in the use of the Kodak Recordak camera for processing bakery orders. Punched card systems were not generally favored. Lyons believed that the rationalisation of clerical procedures that was needed to transfer work to cards would not prove to save costs.

When I joined Lyons in 1949, Simmons was Chief Comptroller and Thompson was Chief Assistant Comptroller. They were in charge of some 2,000 clerical staff who worked in large open plan rooms with 200 clerks carrying out routine payroll calculations, order processing or invoice passing. I found the atmosphere in the clerical department was one of high seriousness of purpose and dedicated loyalty on the part of the staff. Systematic grading of clerical jobs had been pioneered in Lyons' offices and rewards and promotion were strictly related to merit, which was regularly reviewed.

Simmons was totally dedicated to management and especially to the collection and application of management information using the computer. This came out

The LEO I used 5,000 valves (vacuum tubes), drew 30 kw of power of which 3 km were used for cooling fans, and occupied a room 45 feet square. The mercury in the delay tubes weighed half a ton. It executed 700 instructions per second and could produce two-line payslips at the rate of 50 per minute on the line printer.

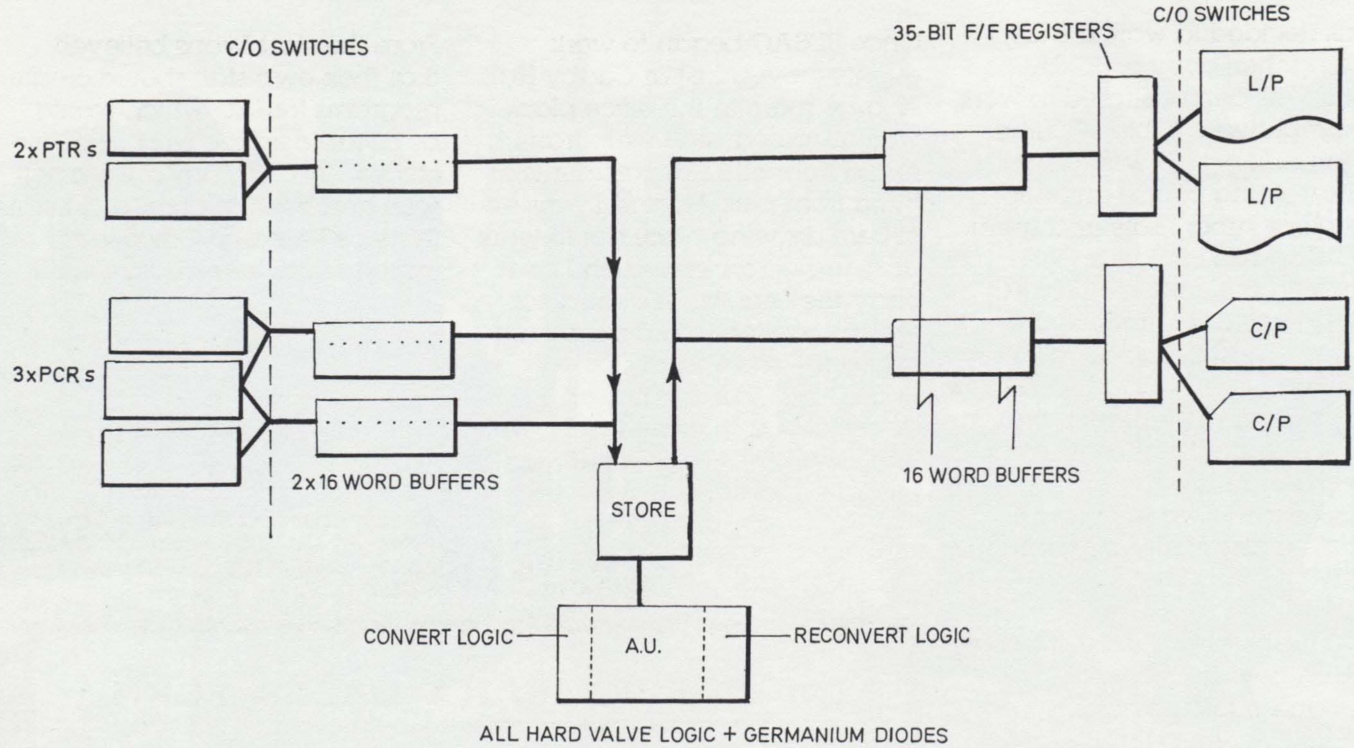
clearly in his second book: *The Management of Change* (1970).

Thompson joined Cadby Hall in 1928, after working in a Liverpool department store. He had the quickest intelligence of anyone I ever met. Much of the inspiration for the hardware development as well as the software of the LEO project came from him. He could quickly visualize ways to organize anything from a complex clerical task to a language compiler down to the finest detail. He maintained the enthusiasm and set the intellectual and management tone of the Leo project from its beginning in 1947 to the merger with English Electric in 1963.

The Birth of LEO

In 1947, Lyons sent Thompson and Oliver Standingford to the USA to investigate the "giant brains" that were then being reported in the British press. An introduction was obtained to meet Professor Goldstine at Princeton who was associated with the ENIAC and specifying the EDVAC. I heard Thompson's account of this meeting several times. It apparently lasted an hour or so. In the first half hour, Goldstine explained to Thompson the principles of the stored program computer. In the second half hour, Thompson explained to Goldstine just how the computer could be employed on routine clerical work, such as payroll and invoicing.

Ironically in the USA, they learned about Maurice Wilkes' EDSAC project underway at Cambridge University. They lost no time in going to Cambridge on returning to the UK. After seeing Wilkes' project, Thompson told me he was impressed by the squareness of the pulses he saw on an oscilloscope in the lab (even though he had no knowledge of electronics). Thompson and Standingford formed a favorable impression of Wilkes' work reported for the Lyons Board. Only a fragment of this has been preserved: "We believe that they have been able to get a glimpse of a development which will, in a few years time, have a profound effect on the way in which clerical work (at least) is performed. Here, for the first time there is a possibility of a machine which will be able to cope, at almost incredible speed, with any variation of clerical procedure, provided the condi-



The overall organization of LEO I as it was built.

tions which govern the variations can be pre-determined. What effect such a machine could have on the semi-repetitive work of the office needs only the slightest effort of imagination. The possible saving from such a machine should be at least £50,000 a year. The capital cost would be of the order of £100,000.

"We feel therefore that the Company might well wish to take a lead in the development of the machine and, indeed, unless organizations such as ours, namely the potential users, are prepared to do so, the time at which they become commercially available may be unnecessarily postponed for many years."

In November 1947, the Board agreed to contribute £2,500 to the cost of the EDSAC and to lend Ernest Lenaerts to Wilkes for six months, which turned out to be nearer a year. Lenaerts, who had worked for Lyons for several years, was employed in electronic engineering during his war service. In return, Wilkes agreed to give Lyons whatever details of the EDSAC design they might need to build a machine for their own use. Lenaerts reported to Thompson on progress.

During 1948 Lyons tried, and failed, to find a contractor to build a machine like the EDSAC. Later that year they decided in principle that when Wilkes' machine had been shown to work, they would build a version of it themselves. They therefore advertised for someone to take charge of the engineering and I applied for the job.

When the anonymous advertisement appeared I suspected it was from Lyons. I had returned to Cambridge after the war to work with Mr J. A. Ratcliffe at the Cavendish Laboratory only 100 yards away from the Maths Lab where Wilkes worked. I wrote a thesis on ultrasonic absorption in liquids using a pulse method which, as it happened, was an ideal preparation for work on computers using delay lines for storage. I first met Wilkes as an undergraduate through the University Wireless Society. In the summer of 1948, Wilkes told me about Lyons' interest in building a computer.

In December 1948, I went for an all day interview at Lyons which was extremely impressive. Not only was I given an excellent lunch, but Mr G. W. Booth, the venerable but alert Director of the clerical department who was over 80 years old, came out to interview me. He asked me if I thought I could make this machine work. I optimistically said I could, but added that as it needed several thousand valves, it would be difficult to make reliable, which naturally turned out to be correct. On December 18th, I got married and in mid January, 1949, I started to work for Lyons.

Construction of LEO 1

Lyons decided to wait to start building their copy of EDSAC after it was demonstrated to work by computing a table of primes. In the meantime, I went to a Lyons training course given to their office supervisors and spent several weeks in Cambridge absorbing the design of EDSAC and its logic and circuit techniques. Ernest Lenaerts and I set up a small workshop to build a delay line and circulate pulses in it. We also tried some ideas for transmitting pulses over long leads because we thought LEO would be physically bigger than EDSAC.

In February 1949, I started discussions on how to deal with the input and output problems revealed by the payroll program. It was recognized that input data would typically fall into one of three categories: (1) current data reflecting events since the last run of the job, (2) data brought forward from that run and (3) semi-permanent data not requiring to be repunched for each run. Similarly results would fall into at least two categories: (1) results to be printed and acted on (e.g., wages to be paid) and (2) results to be carried forward.

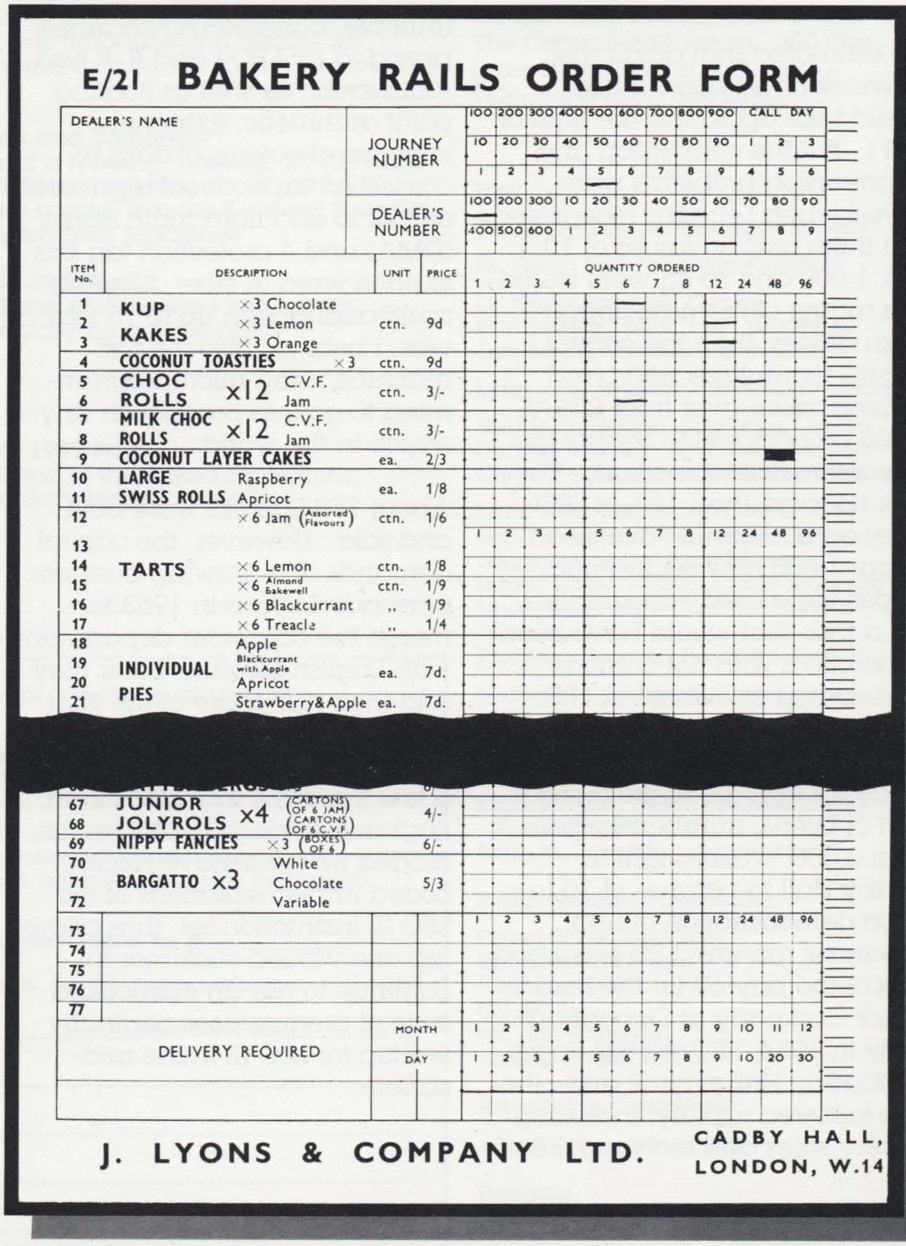
We decided that LEO needed multiple channels for both input and output, to be fitted with buffers that could be read in a single operation and were large enough to hold all the data items of a given kind, e.g., one person on the payroll. We also decided that LEO needed means for converting and reconverting data and results automatically in each channel, rather than using subroutines within the machine. The first of these decisions turned out to be excellent but the second was bad in execution and probably in principle.

Once EDSAC began to work, events moved fast at Cadby Hall. A large room in the office block was allocated, staff were transferred from other departments or hired from outside, and Lyons excellent drawing office got to work drawing up racks and chassis to carry the circuits. A contractor was appointed to build the units, and a revised design of the EDSAC batteries of ultrasonic delay lines was drawn up making full allowance for engineering tolerances.

Putting LEO to work

From the start Lyons believed that their own staff should create programs for LEO which would be suitable for the work of their offices. In 1950, David Caminer who had been in charge of Lyons Systems Research Office was appointed to take charge of all

Handmarked documents at J. Lyons & Company Ltd. to be automatically read and transferred to punched paper tape by LEO in the early sixties.



E/21 BAKERY RAILS ORDER FORM

DEALER'S NAME

JOURNEY NUMBER: 100 200 300 400 500 600 700 800 900 CALL DAY / 10 20 30 40 50 60 70 80 90 1 2 3 / 1 2 3 4 5 6 7 8 9 4 5 6

DEALER'S NUMBER: 100 200 300 10 20 30 40 50 60 70 80 90 / 400 500 600 1 2 3 4 5 6 7 8 9

ITEM No.	DESCRIPTION	UNIT	PRICE
1	KUP KAKES ×3 Chocolate		
2	×3 Lemon	ctn.	9d
3	×3 Orange		
4	COCONUT TOASTIES ×3	ctn.	9d
5	CHOC ROLLS ×12 C.V.F.	ctn.	3/-
6	Jam		
7	MILK CHOC ROLLS ×12 C.V.F.	ctn.	3/-
8	Jam		
9	COCONUT LAYER CAKES	ea.	2/3
10	LARGE SWISS ROLLS Raspberry	ea.	1/8
11	Apricot		
12	×6 Jam (Assorted Flavours)	ctn.	1/6
13			
14	TARTS ×6 Lemon	ctn.	1/8
15	×6 Almond Bakewell	ctn.	1/9
16	×6 Blackcurrant	,,	1/9
17	×6 Treacle	,,	1/4
18	INDIVIDUAL PIES Apple		
19	Blackcurrant with Apple	ea.	7d.
20	Apricot		
21	Strawberry&Apple	ea.	7d.
67	JUNIOR JOLYROLS ×4 (CARTONS OF 6 JAM)		4/-
68	(CARTONS OF 6 C.V.F.)		
69	NIPPY FANCIES ×3 (BOXES OF 6)		6/-
70	BARGATTO ×3 White		
71	Chocolate		5/3
72	Variable		
73			
74			
75			
76			
77			

QUANTITY ORDERED: 1 2 3 4 5 6 7 8 12 24 48 96

DELIVERY REQUIRED — MONTH: 1 2 3 4 5 6 7 8 9 10 11 12; DAY: 1 2 3 4 5 6 7 8 9 10 20 30

J. LYONS & COMPANY LTD. CADBY HALL, LONDON, W.14

LEO programming. Payroll was to be the first main routine task. Since a breakdown in the middle of a two hour job could be serious, the concept of putting out restart totals at the end of each department in the payroll was established early on.

Punched card machines were used for all channels, except those carrying current input data, for which we chose punched tape. Binary, not decimal numbers, were punched into the cards as a compact method of carrying forward results from one run of a job to form the data for the next.

We estimated that doing the conversions by subroutines would take up 90% of the time of LEO I. But the conversion and reconversion problems were solved when Lenaerts recognised that if the binary values of 10, 100, 1,000 and so on were stored in a matrix of the new germanium diodes, then the control circuits for multiplication and division taken over from EDSAC could be adapted to control the two conversion operations. They took no more than 10% of LEO's time, an acceptable overhead. About 1,000 new germanium diodes were used, accomplishing a task that would have been impractical with hot cathode diodes used elsewhere in LEO.

In 1953, when the machine was ready for use, the entire clerical staff of Lyons, numbering more than 2,000, wasbrought to Cadby Hall in batches of 30 to see a demonstration of LEO. Within six months, LEO produced part of the payroll for the Ford Motor Company at Dagenham. Early in 1954, LEO started doing the Cadby Hall payroll and other jobs followed rapidly, including bakery sales and tea shop orders.

Lyons saw LEO I as a considerable success and it remained in service until 1954. They invested in a design of an improved model for small scale production and sale, LEO Mark II, which ran about three times faster than LEO I. Eleven LEO II's were built — all of them slightly different.

Before the end of the fifties, it became obvious that a parallel transistorized machine was feasible and we embarked on LEO III. This was a 40-bit parallel machine of advanced architecture incorporating (as we later found out) many ideas also used in the IBM 360 series. Besides the multiple, buffered I/O channels provided by LEO I and II, it had multi-radix, as well as floating point arithmetic, extremely effective checking of data recorded on tape, direct input and output to and from main store (DMA) and 4 protection tag bits to each word in store allowing multitasking with up to 15 jobs. It was, I believe, also the first machine using microprogramming to go into production anywhere in the world.

About 150 LEO III's were built and sold. However, the capital demands of a growing business persuaded Lyons in 1963 to merge the computer department with English Electric. Later they sold their half share of the joint company to English Electric. While no LEO III's remain in use, a few System 4 machines from English Electric and 2900 series models from ICL have micro coded implementations of the LEO III instruction set, thus allowing one valued customer to continue to use an interlocked suite of programmes originally written for LEO III in the mid-sixties.

Calendar *Winter 1987/88*

Feb 6
Saturday
2 PM

Choreo Graphs
Choreographer Alice Trexler explains her work in computer dance with a live demonstration of body movements interacting with computer screen displays.

Feb 7
Sunday
3 PM

Experiments in Computer Graphics and Art
Graphics pioneer Ken Knowlton will present an illustrated lecture on the evolution of his work from the sixties through the eighties.

Feb 20-21
Saturday-Sunday
10 AM - 5 PM

Third Annual Kids Computer Fair
Try out some of the latest educational and entertaining software for students ages 4-14. Play with robot toys. Learn about computer related activities in a special resource center.

Feb 28
Sunday
3 PM

LEGO/Logo: Building a New World in the Classroom
Stephen Ocko and Mitchel Resnick of MIT's Media Laboratory will demonstrate a LEGO-based smart machine. They will also illustrate how children learn about the world by using personal computers and sensors to transform LEGO building sets into sophisticated toys.

March 6
Sunday
3 PM

Beyond Nature: Computer Graphic Simulations of Life
Peter Oppenheimer of The Computer Graphics Laboratory, New York Institute of Technology, will introduce and discuss his computer-generated experiments that create surreal forms of life captured on video.

March 13
Sunday
3 PM

Intelligent Machines of Today and Tomorrow
Raymond Kurzweil, inventor of a reading machine for the blind and other computer-based devices, will talk about artificial intelligence and introduce the special film the Kurzweil Foundation produced, "The Age of Intelligent Machines".

March 19 and 20
Sat and Sunday
12:30 and 3:00 PM

SIGGRAPH Electronic Theatre 1987 Part 1
Four showings over the weekend of the edited tapes from SIGGRAPH 1987 with commentary by an authority.

March 26 and 27
Sat and Sunday
12:30 and 3:00 PM

SIGGRAPH Electronic Theatre 1987 Part 2
Four showings over the weekend of the edited tapes from SIGGRAPH 1987 with commentary by an authority.

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The Computer Museum

The Computer Museum is a non-profit 501(c)3 foundation that chronicles the evolution of information processing through exhibitions, archives, publications, research and programs.

Museum Hours: *Summer:* Open daily 10 – 5, Friday 10 - 9. *Winter:* Open Tuesday – Sunday 10 - 5, Friday 10 - 9. Open Mondays during Boston school vacation weeks, 10 - 5. Closed Thanksgiving, Christmas, and New Years Day. Hours are subject to change.

Membership All members receive a membership card, free subscription to The Computer Museum Report, a 10% discount on merchandise from The Computer Museum Store, free admission and invitations to Museum previews. For more information contact Membership Coordinator at The Computer Museum, 300 Congress Street, Boston, MA 02210. Telephone (617) 426-2800.

The End Bit 0000000000000001

Among the items in the Museum's ephemera collection was our own "UNIX license." This was made by a group of software people in New Hampshire to look like their state license plate so that they could offer a "UNIX license" to any customer. Donor Anonymous.

Photo: Jerry Rabinowitz

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