

GRACE HOPPER AND THE INVENTION OF THE
INFORMATION AGE

KURT BEYER

THE MIT PRESS
CAMBRIDGE, MASSACHUSETTS
LONDON, ENGLAND

© 2009 Massachusetts Institute of Technology

All rights reserved. No part of this book may be reproduced in any form by any electronic or mechanical means (including photocopying, recording, or information storage and retrieval) without permission in writing from the publisher.

For information on quantity discounts, email special_sales@mitpress.mit.edu.

Set in Engraver's Gothic and Bembo by SNP Best-set Typesetter Ltd., Hong Kong. Printed and bound in the United States of America.

Library of Congress Cataloging-in-Publication Data

Beyer, Kurt W.

Grace Hopper and the invention of the information age/Kurt W. Beyer.

p. cm.—(Lemelson Center studies in invention and innovation series)

Includes bibliographical references and index.

ISBN 978-0-262-01310-9 (hardcover : alk. paper)

1. Hopper, Grace Murray. 2. Women computer engineers—United States—Biography. 3. Computer science—United States—History.

I. Title.

QA76.2.H67B49 2009 004.092—dc22 2008044229

10 9 8 7 6 5 4 3 2 1

INDEX

- Adams, Charlie, 263
- Aiken, Howard, 73–75
and AMC, 169
and Babbage, 130, 136
and Bloch, 86
and computer community,
141–143
and Harvard Computation
Laboratory, 74–88, 92–95
and Harvard Symposium,
143–145, 149, 150, 156–163
and Hopper, 4, 84, 85, 95,
170
and IBM, 109
leadership style, 73, 80–86, 94
and Mark I, 36–43, 55, 63, 64,
68, 74–79, 90, 109, 133, 134,
139, 140
and Mark II, 157–159
and Mark III, 100–103
and Watson, 135
- AIMACO, 290, 292
- Alcoholism, Hopper's, 6,
175–177, 204–207
- American Totalisator, 186, 187,
200
- Analytical Engine, 128, 129
- Arnold, Hubert, 86, 87
- Asch, Alfred, 292
- Asprey, Winifred, 28
- Association for Computing
Machinery (ACM), 7,
163–171, 278, 279, 319,
320
- ATLAS, 172
- Automatic programming,
234–246, 261–268
acceptance, 289
benefits, 223, 224, 275
Hopper and, 10, 221–225,
242–246
- Automatic Programming
Department, 265–267
- Automatic Sequence
Controlled Calculator. *See*
Mark I
- Automatic sequential control,
121

- B-0 language, 270–274
- Babbage, Charles, 127–130, 135, 136, 145–147
- Babbage, Richard, 145–149, 157, 162
- Backus, John, 5, 242, 263, 264, 267–270
- Ballistics Research Laboratory (BRL), 117, 118, 189
- Barnard College, 31
- Bartik, Betty “Jean” Jennings, 5, 190, 191, 218, 219
- Bemer, Robert, 281
- Berkeley, Edmund, 94, 164–169, 177, 204–207
- Binary Automatic Computer (BINAC), 172, 186, 196
- Biography, 18–22
- Bloch, Richard
and Aiken, 81, 86, 160
and coding innovations, 97–100
at Harvard Computation Laboratory, 7, 8, 40–43
and Harvard Symposium, 150, 151
and Mark I, 49, 53, 56–63, 72
at Raytheon, 163
and von Neumann, 115, 116
- Branching, 99, 100, 151
- Bromberg, Howard, 281, 294, 295, 301
- Bugs, 64–72
- Burns, Robert, 80, 84
- Bush, Vannevar, 51, 108, 119
- Cambridge University
Mathematics Laboratory, 96, 97, 103, 197, 198
- Campbell, Robert, 7, 8
and Aiken, 160
and Mark I, 40, 41, 53, 66, 123, 124
at Raytheon, 162, 163
- Census Bureau, 185, 186, 219
- Chaffee, Emory L., 114
- Charles Babbage Institute, 12, 14
- Circuits, 201, 202
- COBOL (Common Business Oriented Language)
Hopper and, 303–309
invention, 280–292, 320, 321
specifications, 288–292
spread, 304–307
standardization, 292–300, 307–310
success, 300–304
- Code
C-10, 193–196, 212
documentation, 16, 63
machine, 193–196, 266, 267
pseudo-, 233–235, 265, 266, 271–275
source, 266, 267, 270–272
- Coding, relative, 98–101
- Coding sheets, 70, 71
- Cold War, 255–261
- Columbia University Statistical Bureau, 132, 133
- Commonwealth Edison, 219
- Compilers, 11, 16, 314

- A-0, 225–229
- A-1, 229
- A-2, 229–242, 264, 267
- A-3, 265, 266
- automatic programming and, 221–225, 263, 264
- business language, 270–275
- distribution, 235–242
- gaining support for, 240–246
- invention, 214–216, 317, 318
- research on, 225–232
- subroutines and, 228–235
- Type B, 224, 239, 240
- “Compiling Routines” (Hopper), 232–235
- Compton, Karl Taylor, 108
- Computer industry, 11, 12, 247–261
- Computer Oral History Collection, 13, 14
- Computers, potential uses of, 154, 155, 180
- Computing community
 - Aiken and, 141–143
 - emerging, 107
 - expansion, 278–280
 - Hopper’s place in, 169–173, 319, 320
 - knowledge sharing in, 143–145, 154–156, 164, 237–239, 277, 278
- Computing-Tabulating-Recording (CTR) Company, 185
- Comrie, Leslie, 105
- COMTRAN, 290, 292, 295
- Conant, James Bryant, 108
- Conference on Data Systems and Languages (CODASYL), 285–296, 320, 321
- Courant, Richard, 29, 30
- Crane, Philip, 2
- Curtiss, John, 166
- Customer support, 219, 220, 252–253
- Data-processing centers, 61
- D-Day, 52, 53
- Debugging, 64–67, 70–72
- Department of Defense, 283–285, 302, 303
- Difference Engine, 127, 128
- Differential analyzer, 51, 52, 239, 240, 315
- Differential equations, 149, 150, 239, 240, 315
- Eckert, J. Presper, Jr., 15, 51, 52, 111, 112, 118, 180–187, 200–202
- Eckert-Mauchly Computer Corporation (EMCC), 4, 10, 172, 173
- financial difficulties, 184–187, 199–204, 208
- Hopper at, 177–184, 191–199
- programmer training at, 196, 197
- purchased by Remington Rand, 208–212, 216–220

- Editing generator, 239, 314
- EDSAC (Electronic Delay Storage Automatic Computer), 65, 66, 97, 105, 197
- “Education of a Computer, The” (Hopper), 220–225
- EDVAC (Electronic Discrete Variable Automatic Computer), 121, 181, 182
- Electronic Control Company, 166, 181
- Emergency Price Control Act and Stabilization Act, 24
- Engineering Research Associates (ERA), 171, 172, 253
- Engstrom, Howard, 35, 171, 172
- ENIAC (Electronic Numerical Integrator and Computer), 8, 9, 15, 51, 52, 61, 69, 108, 118–122, 151, 152, 190, 191, 202, 203
- Errors
 computational, 55, 56
 round-off, 55, 56
- FACT (Fully Automatic Compiling Technique), 293–297
- “First Draft of a Report on the EDVAC” (von Neumann), 111–113, 116–122, 152, 181, 182
- Flow charts, 192, 193
- FLOW-MATIC, 274, 275, 291–296
- Forrester, Jay, 256–258
- FORTTRAN, 267–270, 295
- Gender issues, 211, 212
- Giddens, Anthony, 21
- Gladwell, Malcolm, 306, 307
- Goheen, Harry, 93–95, 165–167
- Goldstine, Herman, 111–113, 117–120, 182, 193
- Gorn, Saul, 281
- Grace Murray Hopper Center, 2
- Grosch, Herbert, 241
- Groves, Leslie, 210, 216, 217, 257
- Hacking, 63
- Hammer, Carl, 240, 241
- Harvard Computation
 Laboratory, 4, 9, 10, 17, 39–43, 53
 Aiken and, 73–88, 92–95
 Berkeley and, 164, 165
 computer community and, 141–143
 Hopper at, 81, 87, 88, 95, 169–177
 humor at, 84, 85
 isolation, 107–111
 postwar environment, 92–95
 pressures, 176, 177
 public relations, 140
 talent migration from, 161–163
 wartime culture and, 89–91, 176
- Harvard Symposium on Large-Scale Digital Calculating Machinery, 143–163

- Harvard University, 12, 141
Hawkins, Bob, 45
History of Programming
 Languages Conference, 7, 12, 13
Holberton, Betty (Snyder), 5, 187–194, 199, 209–212, 236, 288, 303, 304. *See also* Snyder, Betty
Holberton, John, 211, 212
Hollerith, Herman, 185
Honeywell, 293–297
Hopper, Vincent, 25, 26, 30, 31
Hughes, Thomas, 19
- IBM (International Business Machines), 185
 Aiken and, 109
 antitrust lawsuit against, 248, 249
 COBOL and, 292–295, 302, 303
 computers, 258, 259
 culture at, 5, 172
 early computer industry and, 247–261
 EMCC and, 201–204
 Mark I and, 132–137, 148
 SAGE and, 255–261
 Seeber and, 85
Implosion, 99, 114–116, 239, 240
Innovation, 90, 91, 95–106
Input/output mechanisms, 184
Instructional Tape Preparation Table, 101, 103
Internal memory, 9, 100, 101, 121, 152, 183, 184, 266
Interpreters, 234, 235
Interviews, 16–18
Invention, 213, 214, 314–319
 distributed, 11, 225–232, 317, 318
 simultaneous, 103–106
Investment capital, 184–187
- Jacquard, Joseph, 128
Joy, C. Turner, 148, 149
- Kahrimanian, Harry, 239, 240, 315
Koss, Adele Mildred, 219, 239, 314, 315
- Laniung, J. Halcombe, Jr., 263, 264
Leibniz, Gottfried Wilhelm von, 126, 127
Leontief, Wassily, 150
Livingston, Hugh, 196
Lovelace, Ada, 128–130
- Manhattan Project, 113, 114
Manual of Operation for the Automatic Sequence Controlled Calculator (Hopper), 123–130, 137–140
Mark I (Automatic Sequence Controlled Calculator), 7, 9
 Aiken and, 36–43, 55, 63, 64, 68, 74–79, 90, 109, 133, 134, 139, 140

- bugs, 66–72
- commercial potential, 90, 91
- design, 45–51, 90
- Hopper and, 87, 88
- IBM narrative, 132–137
- manual for, 123–130, 137–140
- operating instructions, 57, 58
- output, 60, 61
- performance, 144, 148
- postwar environment and, 92–95
- processing speed, 62–64, 115
- programming, 47–49, 53–62, 70–72
- subroutines, 96
- testing, 59, 60
- von Neumann and, 111–116
- Mark II, 7, 53, 90, 93, 147, 148, 157–159, 184
- Mark III, 93, 100–103, 214, 221, 222
- Marriage, 25, 26, 31
- Massachusetts Institute of Technology (MIT), 108, 109, 255–258
- Mathematical functions, 50
- Mathematical models, 150
- Mathematics, 15, 16, 25, 28
- MATH-MATIC, 266, 267
- Mauchly, John
 - and ACM, 166, 167
 - and EDVAC, 181–183
 - and EMCC, 173, 177–181, 199–201
 - and ENIAC, 51, 52, 69, 118
 - and “First Draft,” 111, 112
 - and IBM, 201–204
 - and Remington Rand, 210–212, 217
 - and UNIVAC, 184–187
- McAfee, Mildred, 32
- Mealey, Marilyn, 311–313
- Memory, 151, 158, 257
- Mercury delay lines, 158, 159, 183
- Microsoft, 6
- Midshipmen’s School, 32–34
- Mitchell, Herbert, 196, 218
- Mitchell, Maria, 26
- Morton, Paul, 158
- Moser, Nora, 237
- Murray, Roger, 31
- National Bureau of Standards, 186
- National Museum of American History, 12, 13, 16
- Naval Data Automation Headquarters (NAVDAC), 322–324
- Navy, 3, 4, 32–43, 322–324
- Navy Communications Annex, 35
- Navy Programming Languages Group, 322
- Navy Women’s Reserve Act, 31
- Nelson, D. A., 298
- Nomenclature Committee, 278, 279, 320
- Nutt, Roy, 293
- Nye, David, 20

- Operating instructions, 57, 58, 71, 102
- Operators, 56, 57
- Oppenheimer, J. Robert, 73
- Oral histories, 13–18
- Pacific Mutual Insurance Company, 251, 252
- Palmer, Ralph, 203
- Partial differential equations, 30, 55
- Pascal, Blaise, 126
- Pearl Harbor, 3, 23, 24, 31
- Personal difficulties, Hopper's, 5, 6, 31, 175, 176, 204–207
- Phillips, Charles, 280–284, 302, 303
- Primary sources, 12–14
- Problem-oriented languages, 263–275
- Professor, Hopper as, 25–32
- Programmers
 shortage, 254, 255
 training, 196, 197, 264, 265, 319
- Programming, 62
 costs, 244, 245, 265, 282, 284
 history, 313, 314
 innovations, 90, 91, 95–106
 as invention, 6–12
 Mark I, 47–49, 53–66, 70–72
 techniques, 7, 8
- Programs, portability of, 283, 284
- Project Whirlwind, 256–259, 263
- Punch cards, 201, 202, 209
- RAND Corporation, 261
- Rand, James, 208, 209
- Random-access memory (RAM), 158, 257, 258
- RAYDAC, 163
- Raytheon Manufacturing Company, 162, 163
- RCA, 294–296
- Relay technology, 68, 69, 90, 147, 158–160
- Remington Rand Corporation, 5
 Hopper and, 11, 219, 220, 254
 IBM and, 247–261
 management, 242–246
 purchase of EMCC by, 208–212, 216–220
 sales and support for UNIVAC at, 216–220, 252–254
 UNIVAC and, 249–254
- Retirement, Hopper in, 322–324
- Reynolds, Edward, 148
- Richards, Ellen Swallow, 26
- Ridgway, Richard, 225–229
- Run-programs, 226
- 60 Minutes* interview, of Hopper, 1, 2
- 604 Electronic Calculator, 203
- SAGE (Semi-Automatic Ground Environment), 255–261
- Sammert, Jean, 7, 289, 290, 294
- Saunders, Frederick, 75, 76
- Savage, David, 217
- Schell, Emil, 236
- Seeber, Robert, 85

- Selective Sequence Electronic Calculator, 85
- Shapley, Harlow, 76, 78
- Smith, Eugene, 283
- Smith, Gertrude, 28–39
- Smithsonian Institution, 12, 13, 16
- Snyder, Betty, 5, 187–194, 199, 209–212, 236, 288, 303, 304.
See also Holberton, Betty (Snyder)
- Social constructivism, 19–21
- Software development, 6
- Sorting, binary, 198, 199
- Sort-merge generator, 198–202
- Sperry Rand, 274, 290, 291
- Stibitz, George, 69
- Storage technology, 158, 159
- Stored-program architecture, 120, 121, 152, 192, 193
- Straus, Henry, 186, 187, 199–201
- Subroutines, 96–106, 195, 196, 222, 223, 228–235
- Suicide threats, Hopper's, 206, 207
- Tapes
data, 59
magnetic, 184, 198–204
sequence, 59
- Teaching career, Hopper's, 26–30
- Technology, history of, 18–22
- Travis, Irvin, 181
- Turing, Alan, 107
- UNIVAC, 105, 172, 181–184
C-10 code and, 193–196
demand for, 251–254
design, 183–184, 198, 199
and Eisenhower-Stevenson election, 249–251
investment capital for, 184–187, 200–204
Remington Rand and, 208–212
sales and support for, 216–220, 252–254
- University of Pennsylvania, 8
- USS Grace Hopper*, 2
- Vacuum tubes, 69, 90
- Vassar College, 25–32
- von Neumann architecture, 9
- von Neumann, John, 8, 9, 96, 104
and AMC, 168, 169
and “First Draft,” 111–113, 116–122, 152, 181, 182
and flow charts, 193
and Harvard Symposium, 153, 154
and Mark I, 111–116
- War Powers Act, 24
- Watson, Thomas, Jr., 201–203, 256–259
- Watson, Thomas, Sr., 109, 135, 172, 185, 201, 202
- WAVES (Women Accepted for Volunteer Emergency Service), 31, 32

- Weaver, Warren, 77
- Wheeler, David, 97
- Wiener, Norbert, 152, 153
- Wilkes, Maurice, 64, 65, 83, 84,
96, 97, 104–106, 157, 197,
198
- Women, career opportunities for,
3–5
- World War II, 3, 4, 23, 24,
30–34, 52, 53, 89–91, 107
- Zierler, Neal, 263, 264

Grace Hopper and the Inve has been added to your Cart. Add to Cart. Buy Now.Â Hopper's work to convene the CODASYL group was the first of a long line of standards efforts (including ICANN and the rest of the Internet infrastructure) without which the Information Age would have withered for lack of cross-enterprise fertilization. Read more. 34 people found this helpful. The career of computer visionary Grace Murray Hopper, whose innovative work in programming laid the foundations for the user-friendliness of today's personal computers that sparked the information age. A Hollywood biopic about the life of computer pioneer Grace Murray Hopper (1906â€“1992) would go like this: a young professor abandons the ivy-covered walls of academia to serve her country in the Navy after Pearl Harbor and finds herself on the front lines of the computer revolution. She works hard to succeed in the all-male computer industry, is almost brought down by personal problems but

