

Women in Computing



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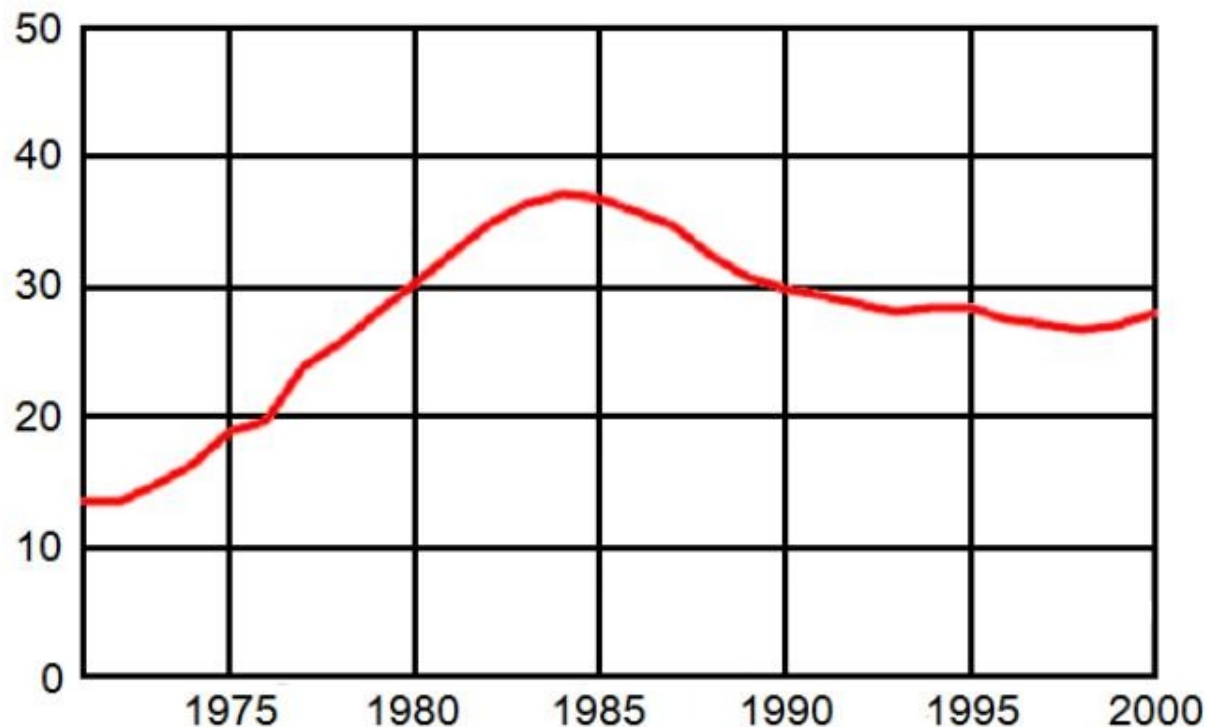
An Amazing Photo



Philadelphia Inquirer, "Your Neighbors" article, 8/13/1957

Diversity Crisis in Computer Science

Percentage of CS/IS Bachelor Degrees Awarded to Women



National Center for Education Statistics, 2001

Goals of this talk

- Highlight the many accomplishments made by women in the computing field
- Learn their stories, both good and bad

Augusta Ada King, Countess of Lovelace

- ❑ Translated and extended Menabrea's article on Babbage's Analytical Engine
- ❑ Predicted computers could be used for music and graphics
- ❑ Wrote the first algorithm— how to compute Bernoulli numbers
- ❑ Developed notions of looping and subroutines



Garbage In, Garbage Out

The Analytical Engine has no pretensions whatever to originate anything. It can do whatever we know how to order it to perform. It can follow analysis; but it has no power of anticipating any analytical relations or truths.

— Ada Lovelace, Note G

On her genius and insight

If you are as fastidious about the acts of your friendship as you are about those of your pen, I much fear I shall equally lose your friendship and your Notes. I am very reluctant to return your admirable & philosophic 'Note A.' Pray do not alter it...

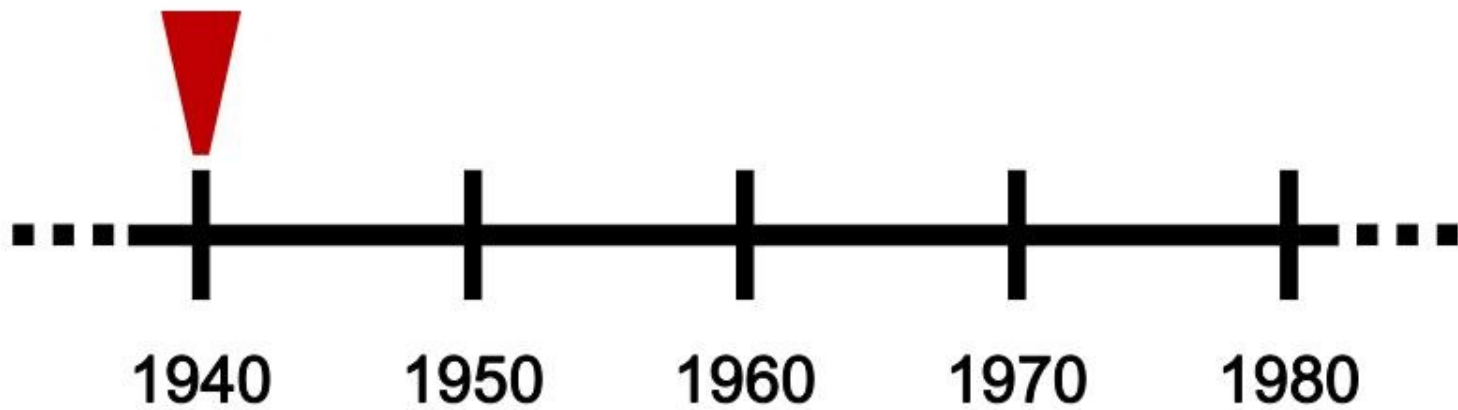
All this was impossible for you to know by intuition and the more I read your notes the more surprised I am at them and regret not having earlier explored so rich a vein of the noblest metal.

— Charles Babbage

Science Publications for Victorian Ladies

- ❑ Some journals accepted and supported science papers from women authors.
- ❑ Periodical like the *Edinburgh Review and Ladies Diary* also provided opportunities for publishing amateur scholarly works.

Timeline



Human Computers

- ❑ Manual calculation of differential equations for generating tables to be used on the battlefield (e.g., trajectories)
 - ❑ Supported through use of mechanical calculators
 - ❑ A few specialized in the use of single-purpose hardware (e.g., differential analyzer)
- ❑ Alternative to a career teaching mathematics
- ❑ Women more prominent as computers
 - ❑ Large pool of potential employees (both college and high school graduates)
 - ❑ Cheaper than hiring men
- ❑ Moore School of Engineering, University of Pennsylvania

The Women of ENIAC

- Six “computers” hired to be the first programmers for the ENIAC project (1945)



Kay Antonelli



Jean Bartik



Betty Holberton



Marlyn Meltzer



Frances Spence



Ruth Teitelbaum

- Women comprised a large percentage of later programmers for ENIAC, including
 - Homé McAllister
 - Willa Wyatt Sigmund
 - Marie Bierstein
 - Marie Bierstein

Working on the ENIAC

- ❑ Learned the system through its blueprints and conversations with its designers
- ❑ Worked in pairs on subprojects:
 - ❑ Calculating and testing test trajectories:
Marlyn Meltzer and Ruth Teitelbaum
 - ❑ Developing and streamlining the programs:
Frances Spence and Kathleen Antonelli
 - ❑ Coordinating the Master Programmer unit:
Jean Bartik and Betty Holberton
- ❑ Only group to program ENIAC at the machine level

After ENIAC

- ❑ Ruth Teitelbaum
 - ❑ Stayed with ENIAC project the longest
 - ❑ Trained second generation of ENIAC programmers
- ❑ Jean Bartik
 - ❑ Conversion of ENIAC to a stored-program computer
 - ❑ Worked on BINAC and UNIVAC I
- ❑ Kathleen Antonelli
 - ❑ Married John Mauchly (1948)
 - ❑ Software design for the BINAC and UNIVAC I
- ❑ Betty Holberton
 - ❑ Suggest grey as the color for UNIVAC I
 - ❑ Developed C-10 mnemonic instruction set for BINAC

Dustbin of history?

- ❑ For 50 years, their involvement was mostly forgotten and ignored:
 - ❑ Hardware more the focus than the software
 - ❑ Names misspelled in official Army history
 - ❑ Some programmers married ENIAC engineers
- ❑ Programmers originally not invited to 50th anniversary of ENIAC
- ❑ All six programmers inducted into the Women in Technology International Hall of Fame (1997)

Grace Hopper (1 of 3)

□ Education

- Vassar: B.S. in Mathematics and Physics
- Yale: M.S. and Ph.D. in Mathematics

□ Naval Career

- Joined Naval Reserves (1943)
- Assigned to work with Howard Aiken

□ Harvard

- First person to write a program for the Mark I (arctangent calculations)
- Member of the Mark II and III development teams



The Infamous Bug

- While working on the Mark II, Hopper discovered a moth stuck in a relay.



- Originated the term “debugging”

Grace Hopper (2 of 3)

□ UNIVAC

- Invented concept of compiler: ARITH-MATIC, MATH-MATIC and FLOW-MATIC
- COBOL was partially an extension of FLOW-MATIC

□ Standards

- Advocated and pioneered development of standards for testing computer systems and languages.



Grace Hopper (3 of 3)

□ Naval Career

- Retired three times
- Promoted to Rear Admiral by special Presidential appointment (1983)
- Defense Distinguished Service Medal recipient (1986)

□ Digital Equipment Corporation

- Senior Consultant and Goodwill Ambassador (1986 – 1992)

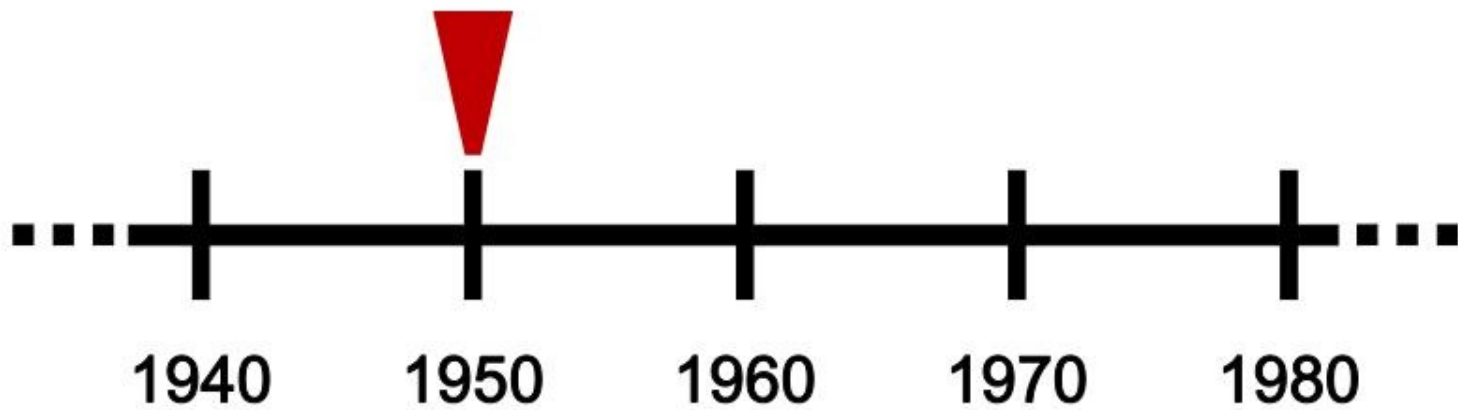


Nanoseconds

- ❑ To demonstrate the cost of computing time, Hopper would hand out pieces of wire.
- ❑ Distance electrons travel:
 - ❑ 1 nanosecond \approx 12 inches
 - ❑ 1 microsecond \approx 1000 feet
 - ❑ 1 millisecond \approx 189 miles
 - ❑ 1 second \approx 189,000 miles



Timeline



Judith Levenson Clapp

- ❑ MIT Whirlwind Project (1950s)
 - ❑ Only woman on the air defense system subproject
- ❑ Software Engineering
 - ❑ Pioneered development of software management tools for large systems
 - ❑ “Virtual” founder of the field



Early Women Programmers

When computer programming was becoming a field, there was a belief that it was women's work because [women] were neat, organized, etc. Programming paid more than other jobs that women had during that period, and we knew we were contributing something and we liked that.



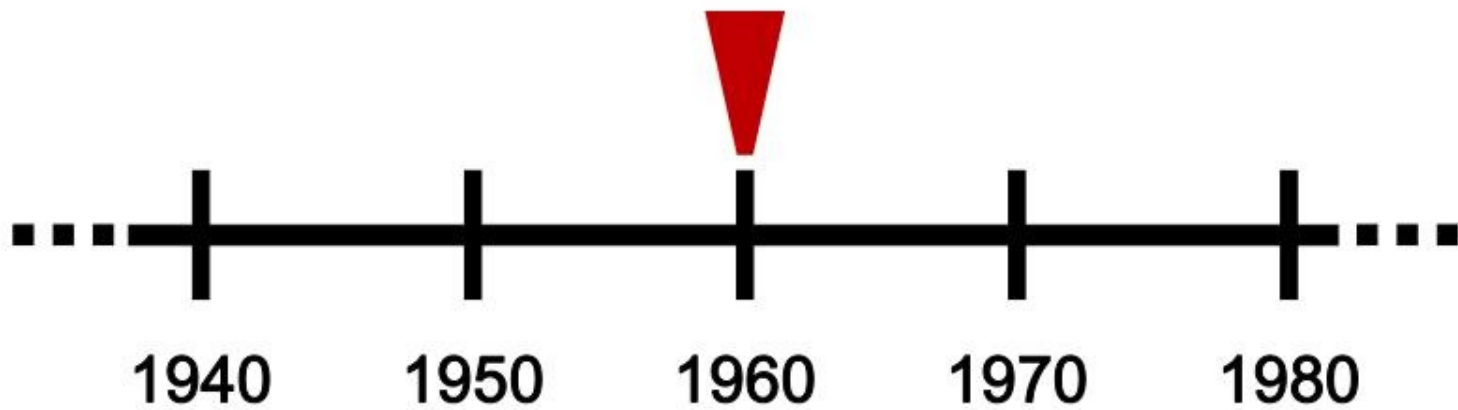
Smith Alumnae Quarter, Summer 2005

Thelma Estrin

- WEIZAC (1951 – 1955)
 - One of the initial two engineers to work on the first large-scale electronic computer built outside the United States and Western Europe
- Biomedical Engineering
 - Computer systems for analyzing and capturing neuron firing
 - Early advocate for medical informatics
- First recipient of the Association of Women in Computing's Augusta Ada Lovelace Award (1982)



Timeline



Sister Mary Kenneth Keller

- ❑ First woman to earn a PhD in computer science (University of Wisconsin-Madison)
- ❑ At Dartmouth, broke the “men only” rule and helped develop BASIC.
- ❑ Faculty at Clarke College (Iowa):
 - ❑ Founded the computer science department
 - ❑ Established a masters program for computer applications in education.



The First PhDs in Computer Science?

- The first PhDs designated as "Computer Science" were awarded by the University of Pennsylvania:
 - Richard Wexelblat (December, 1965)
 - Andries van Dam, (May, 1966)
- Keller earned her PhD in May, 1965 from the University of Wisconsin-Madison

Lynn Conway

- Before 1999, Lynn Conway was already well respected for her many accomplishments:
 - VLSI work at Xerox PARC
 - DARPA / Strategic Defense Initiative
- In 1999, she disclosed that she was a transsexual women.
- Prior to her transition, her work at IBM included the invention of a fundamental component of today's modern superscalar computers.



“Robert’s” Career at IBM

- The secret ACS-1 Supercomputer Project
 - Goal: Develop a high-performance supercomputer
 - Many great minds on this project:
Herb Schorr, Fran Allen, Jim Beatty, Ed Sussenguth,
Don Rozenberg, Charlie Freiman, and John Cocke
- Position:
 - Developer of a microarchitectural timing simulator
 - Involved in many architectural discussions
- John Cocke’s critical question:
How can the machine execute more than one instruction per machine cycle, on average?

Dynamic Instruction Scheduling

- The Shower Insight:
 - Use a special queue to issue multiple instructions out of order based on certain independence constraints
 - Matrices of many transistors evaluate independence
- DIS rapidly integrated into the ACS architecture

	Instruction	Source Matrix								Destination Matrix								Busy Vector							
		1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
1.	$R_3 + R_4 \rightarrow R_7$			1	1											1				1				1	
2.	$R_7 \times R_2 \rightarrow R_4$		1						1				1												
3.	$R_1 + R_2 \rightarrow R_5$	1	1											1											
4.	$R_8 \div R_1 \rightarrow R_8$	1							1							1									

Fig. 2

Legacy of Dynamic Instruction Scheduling

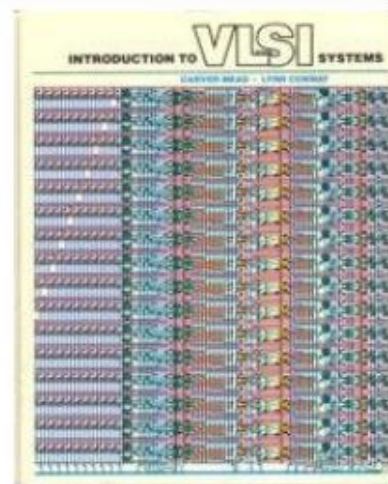
- Within IBM:
 - ACS-1 project cancelled (1968)
 - Knowledge spread slowly in and outside of IBM
 - Critical component of all modern superscalar computers
- Patent status:
 - For “Robert”: DIS viewed as only a software idea
 - IBM patented aspects of DIS with the ACS-360
- Claim of invention:
 - Multiple claimants in the 1980s
 - Historical investigation by Dr. Mark Smotherman and Conway’s archive establish her as the original innovator

Transition, Firing, and Starting Over

- ❑ Conway announces transition to IBM management
 - ❑ ACS project team supports her continuing at IBM
 - ❑ Management fires Conway
- ❑ Transition and gender reassignment surgery
- ❑ Starting over:
 - ❑ IBM colleagues unable to offer jobs or help
 - ❑ Conway withheld being transsexual only after a job offer was given
 - ❑ Many offers rescinded after being given this knowledge
 - ❑ Restarted her career as a contract programmer

PARC and the Start of VLSI

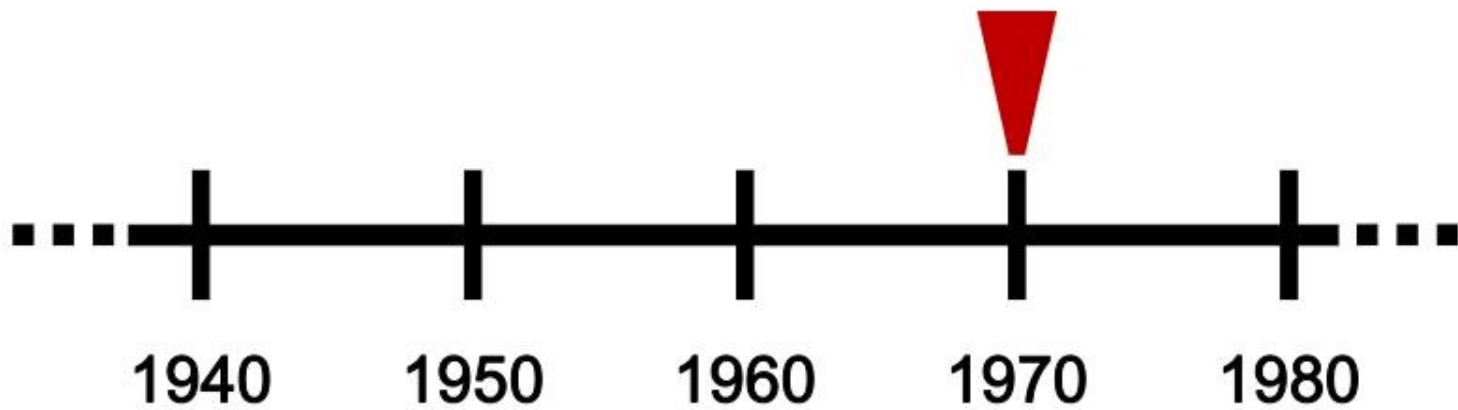
- Conway joins Xerox PARC (1973)
- With Doug Fairbairn and Carver Mead, establishes the “LSI Systems Area”
 - Conway recognizes need to design the design process for transistor layout
- Mead-Conway textbook developed
 - Design course tested at MIT (1978)
 - Tested at multiple universities with ARPANET support for collaboration (1979)
 - Success and adoption of VLSI methods



DARPA and Beyond

- DARPA
 - Conway joins DARPA (1982)
 - Technical Architect, Strategic Computing Initiative
- Elected to National Academy of Engineering (1989)
- University of Michigan
 - Joined U of M (1985) as Associate Dean of Engineering
 - Emeritus status (1999)
- Transgender Advocacy
 - Since revealing her past in 1999, Conway has become a strong voice in defending the rights for both the transgender and GLB communities

Timeline



Anita Jones

- ❑ PhD from Carnegie-Mellon (1973)
- ❑ Founded Tartan Laboratories with Bill Wulf (1981)
- ❑ Federal Director of Defense Research and Engineering (1993-1997)
 - ❑ Highest position ever held by a woman in the Department of Defense



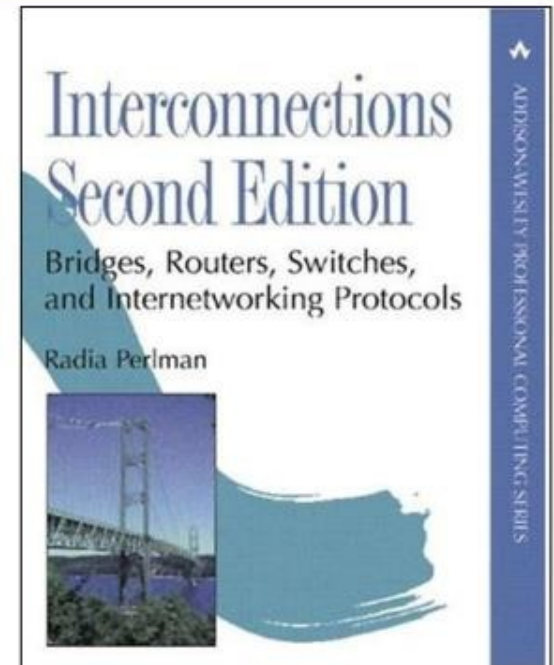
Radia Perlman

- ❑ MIT Logo Lab (1970s)
 - ❑ Invented tangible computing
- ❑ BBN Technologies (1976-1980)
- ❑ Digital Equipment (1980-1993)
 - ❑ Developed DECNet routing protocols
- ❑ Novell (1993-1997)
- ❑ SUN Microsystems (1997-Present)
- ❑ Women of Innovation Award (2005)



Mother of the Internet

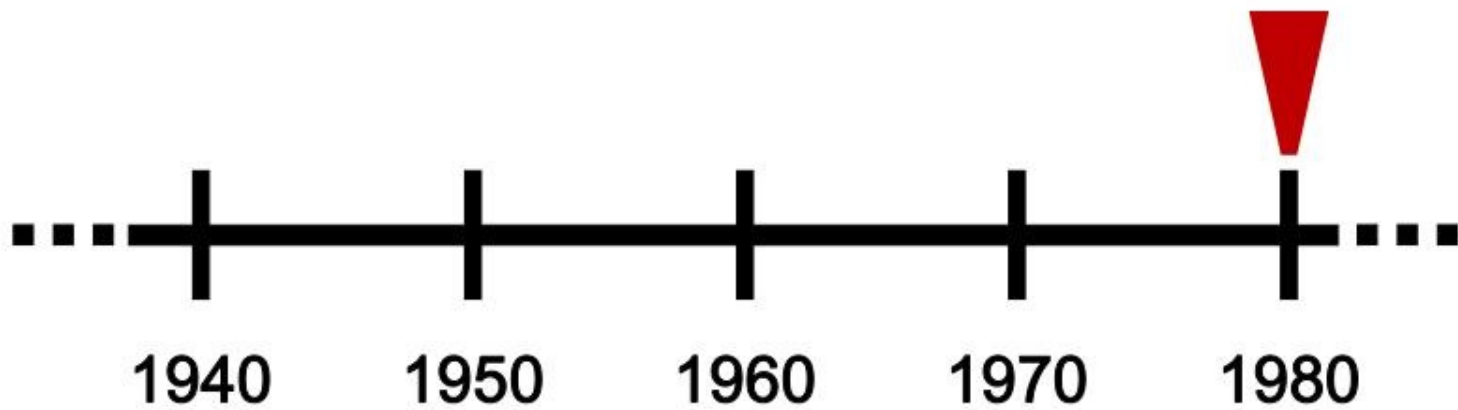
- ❑ Spanning Tree Network Protocol
- ❑ Network Layer Protocols with Byzantine Robustness
- ❑ 80 patents for various nuances of network systems technology



Many claim to be the Father of the Internet, but there is only one 'Mother,' and that is Radia Perlman.

— Greg Papadopoulos, CTO Sun Microsystems

Timeline



Anita Borg

- ❑ Xerox PARC:
MECCA Communications and Information Systems project
- ❑ Presidential Commission on the Advancement of Women and Minorities in Science, Engineering, and Technology (1999)
- ❑ Founded the Institute of Women in Technology:
 - ❑ Bring non-technical women into the design process
 - ❑ Encourage more women to become scientists
 - ❑ Help the industry, academia, and the government accelerate these changes



Maria Klawe

- ❑ ACM President (2002-2004)
- ❑ University of British Columbia:
 - ❑ Department Chair (1988-1995)
 - ❑ Vice President of Student and Academic Services (1995-1998)
 - ❑ Dean of Science (1998-2002)
- ❑ Princeton University
 - ❑ Dean of Engineering and Applied Sciences (2002-2006)
- ❑ Harvey Mudd College:
 - ❑ President (2006-present)

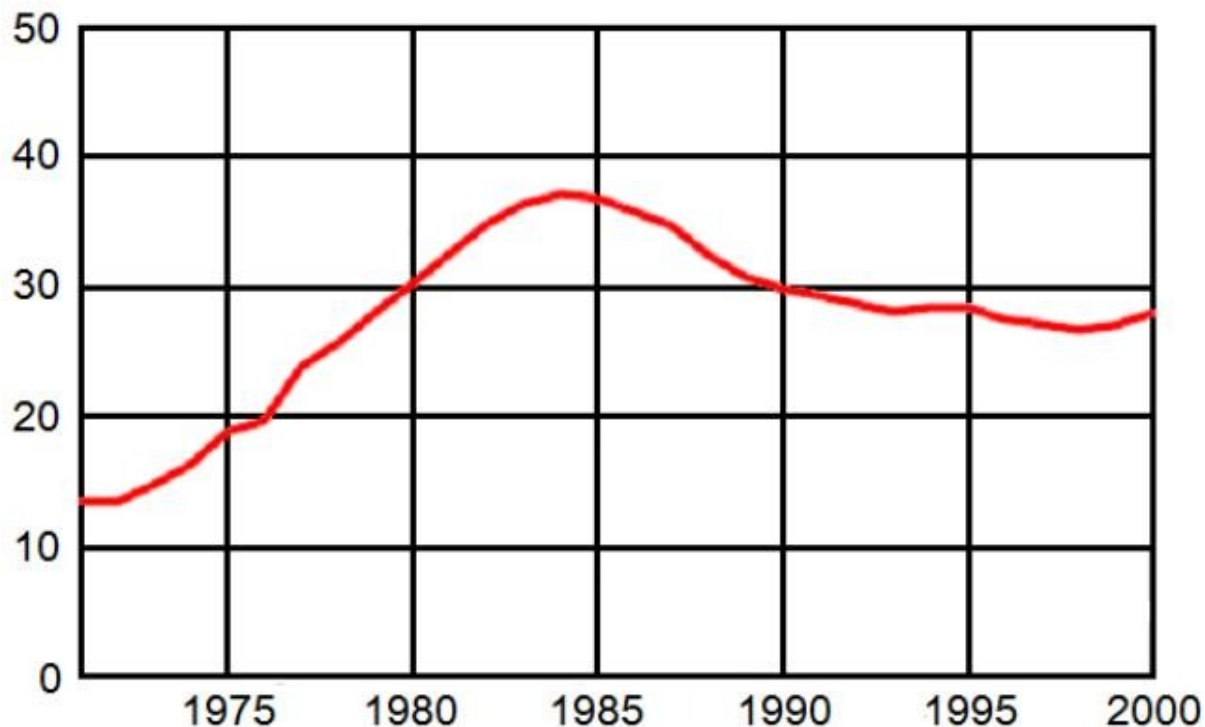


Plenty of others to mention

- Susan Eggers
- Nell Dale
- Jean Sammet
- Barbara Liskov
- Henriette Avram
- Lenore Blum
- Fran Berman
- Evelyn Boyd Granville
- Irma Wyman
- Barbara Simons
- Fran Allen
- Irene Grief
- Adele Goldberg
- Sophie Wilson
- Judy Estrin
- Any many more...

So... here we are...

Percentage of CS/IS Bachelor Degrees Awarded to Women



National Center for Education Statistics, 2001

The past was not so rosy

- ❑ Despite the achievements of the women presented here, the past 60 years of computing was not gender-equal:
 - ❑ Pay disparities
 - ❑ Women only in lower-level positions, not management
 - ❑ Family versus career conflicts
 - ❑ Being outright ignored

Factors of success for these women

- ❑ Opportunity
- ❑ Encouragement
- ❑ Application
- ❑ Interest

Hurdles to Overcome

- ❑ Negative stereotypes of computer science
- ❑ Biases and lack of support for family planning in career decisions
- ❑ Lack of encouragement for women to pursue careers in many of the sciences
- ❑ Misogynism

Efforts: Past, Present, and Future

- K-12 Outreach
- “Unlocking the Clubhouse: Women in Computing” by Margolis and Fisher
- Systems
- ACM-W
- Grace Hopper Conference
- And many other efforts...

Some final points

- Diversity is not just about women.
 - Race, ethnicity, experiences, etc. also matter.
 - Men are minorities in certain fields (e.g., nursing).
- Diversity is a pipeline issue.
- Social issues need all of us to be involved.
- Change will not come instantly.

A final quote

Recently a recruiter for a company sent me e-mail saying "We are particularly interested in you as a female thought leader." I didn't reply, because I wasn't interested in a job, but I fantasized replying: "Thank you for your interest. Although my credentials as a thought leader are impeccable, I must warn you that I am not that qualified as a female. I can't walk in heels, I have no clothing sense, and I'm not particularly decorative. What aspects of being female are important for this position?"

— Radia Perlman

