Restoring and Demonstrating 1960s Vintage Computers at the Computer History Museum

Robert Garner
IBM 1401 Restoration Project Lead Volunteer

Making IT Work Conference
Computer Conservation Society
London, May 22, 2017

THE COMPUTER HISTORY MUSEUM

The world's leading institution exploring the history of the computing revolution and its ongoing worldwide impact on the human experience.

- **Collections and Exhibitions:** >109,000 computing artifacts and 834 oral histories. Hosts 200,000 visitors annually.
- **Specialized Programs & Events:** Speaker series (CHM Live!) and events with prominent tech leaders.
- **Educational Outreach**: Educational programming reaching 18,000 students annually.
- **Innovation and Entrepreneurship Center:** Engages and cultivates new audiences with innovators and change makers.
- **Young Professionals:** Next Gen Advisory Board events, large social media reach.

Exhibitions

Exhibitions showcase the Museum's unique and large collection, and engage new audiences with technology and stories in a venue dedicated to innovation.

Revolution

- Chronicles the evolution and impact of computing from the abacus to smart phone
- 25,000 square feet in 19 galleries
- Features >1,000 artifacts and videos
- Engages audiences through docent-led tours and technology demonstrations

Make Software: Change the World!

- An interactive exhibit that explores the impact software makes on everyday lives

Speaker Series: CHM Live!

CHM Live! is a multi-media program with a world-wide distribution on the web, regional and national public radio & television.

Past speakers include:

- Ed Catmull. *Pres., Pixar & Walt Disney*
- Marissa Mayer, *CEO, Yahoo!*
- Elon Musk, *CEO, Tesla Motors, SpaceX*
- Sheryl Sandberg, *COO, Facebook*
- Eric Schmidt, *Chairman, Google*
- Mark Zuckerberg, *CEO, Facebook*

Education

Design_CODE_Build
Interactive events for “underrepresented in high-tech” middle school students, introducing basic concepts behind coding to excite students about pursuing STEM in their education and future careers.

Talking to the Future
High school students engage with innovative entrepreneurs and tech industry leaders through design challenges, interactive demos and speaker panels, and inspiring activities designed for collaboration.

School Group Visits
11,000 students annually visit the museum for free school visits to participate in interactive workshops related to STEM disciplines.

Vintage restorations and live demos

DEC PDP-1 Demo Lab

Showcases SpaceWar! video game on eerie CRT, music synthesis.
Demos: first and third Saturdays of month

IBM 1401 Demo Lab

Showcases the lively line printer, punched-card equipment, keypunches, tape drives.
Demos: Wednesday afternoons and Saturday mornings

IBM 350 1st Disk Drive Demo

Showcases operational 50-platter disk and access arm. Located in Revolution exhibit.
Demos: Wednesday afternoons

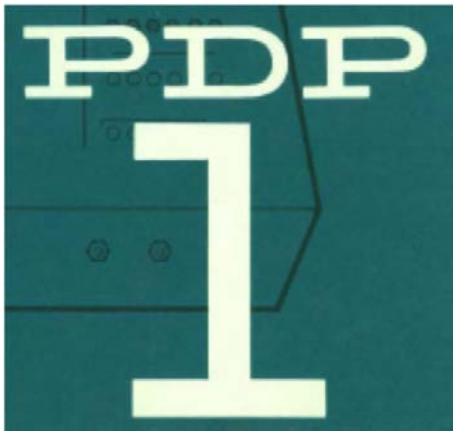
RESTORATION

(1998 – 2000)

No longer demo'd

IBM 1620 restoration

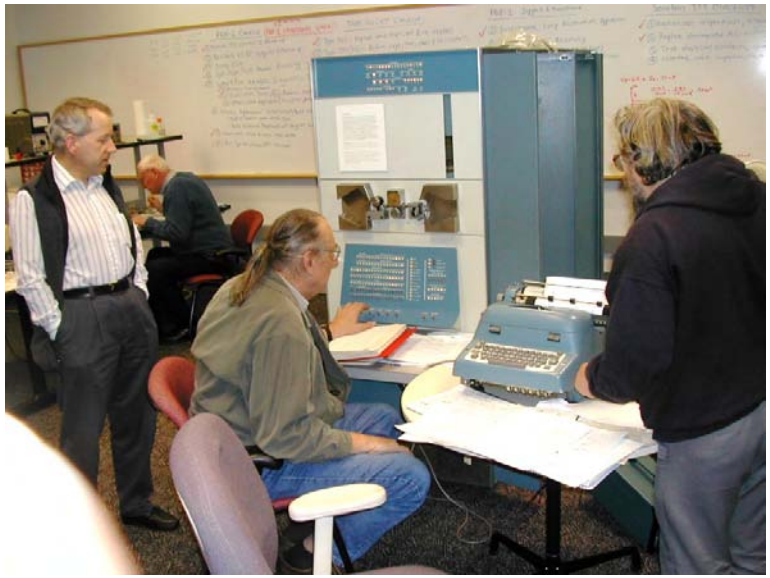
digital equipment corporation



RESTORATION & DEMOS

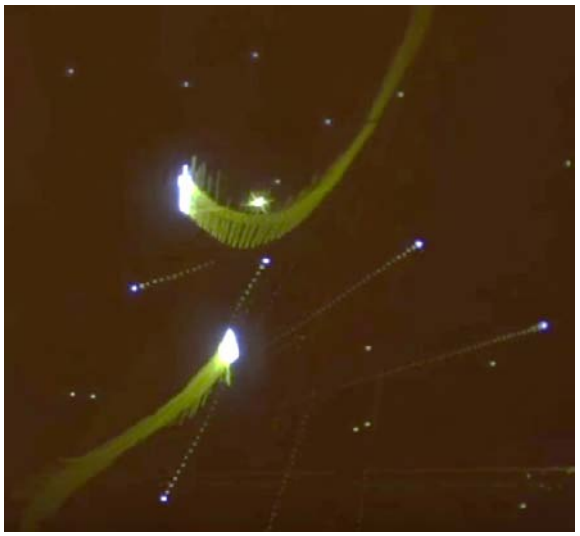
(2003 – 2006, ongoing)

DEC PDP-1 restoration

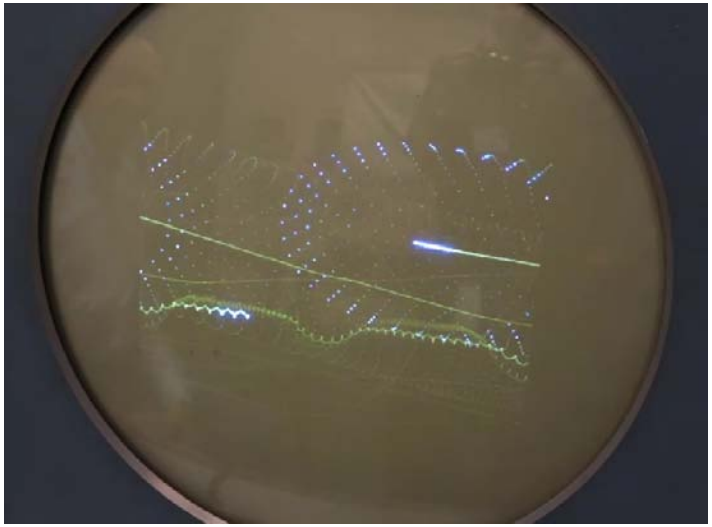


PDP-1 demos

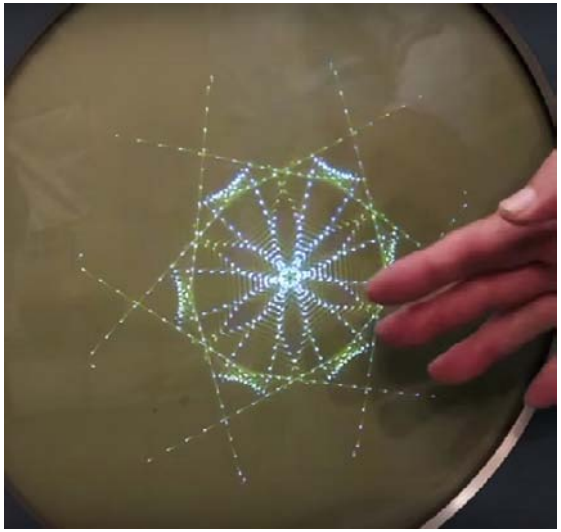
PDP-1 demos with CRT display



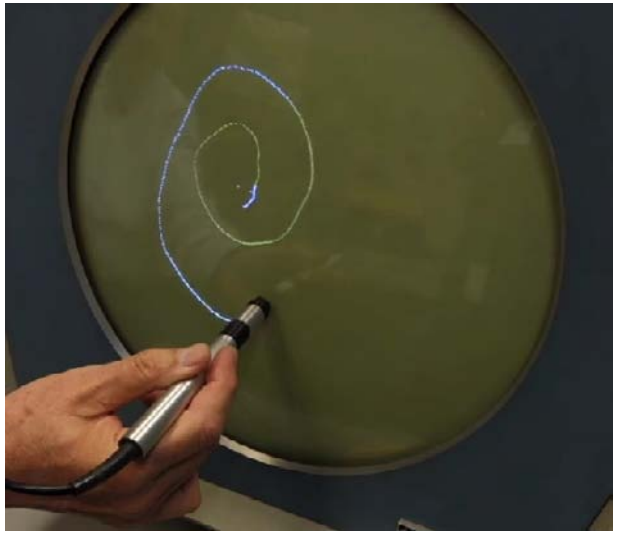
Spacewar!



Minskytron



Snowflake



Light Pen

PDP-1 special visitors

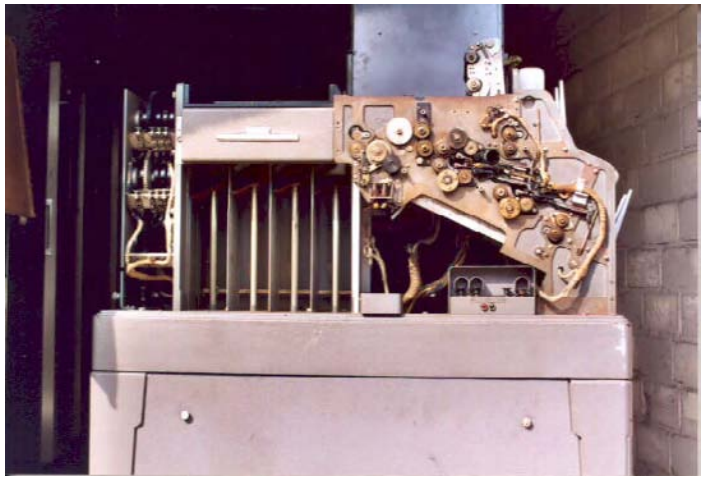
Bill Gates

Gordon Bell

TWO RESTORATIONS

(2004 – 2009, ongoing)

DE 1401, Hamm, Germany (2004)



How to find a restoration team?

An IBM 1401 Needs Help

The Computer History Museum in Mountain View is looking for volunteers to help restore an historic IBM 1401 Data Processing System it has just acquired. Needed are retired IBM Field or Customer Engineers who serviced vintage IBM systems from the early 60's. Anyone who is interested in bringing this system back on-line, helping with programming, or becoming a Museum visitor docent would be welcome. Experience in mechanical systems (gearing, etc.) would be priceless.

The Museum's new 1401 was last operational in Germany in the 1980's. It was carefully stowed away by it's lifelong customer engineer, who will travel to the Museum to help bring it back to life.

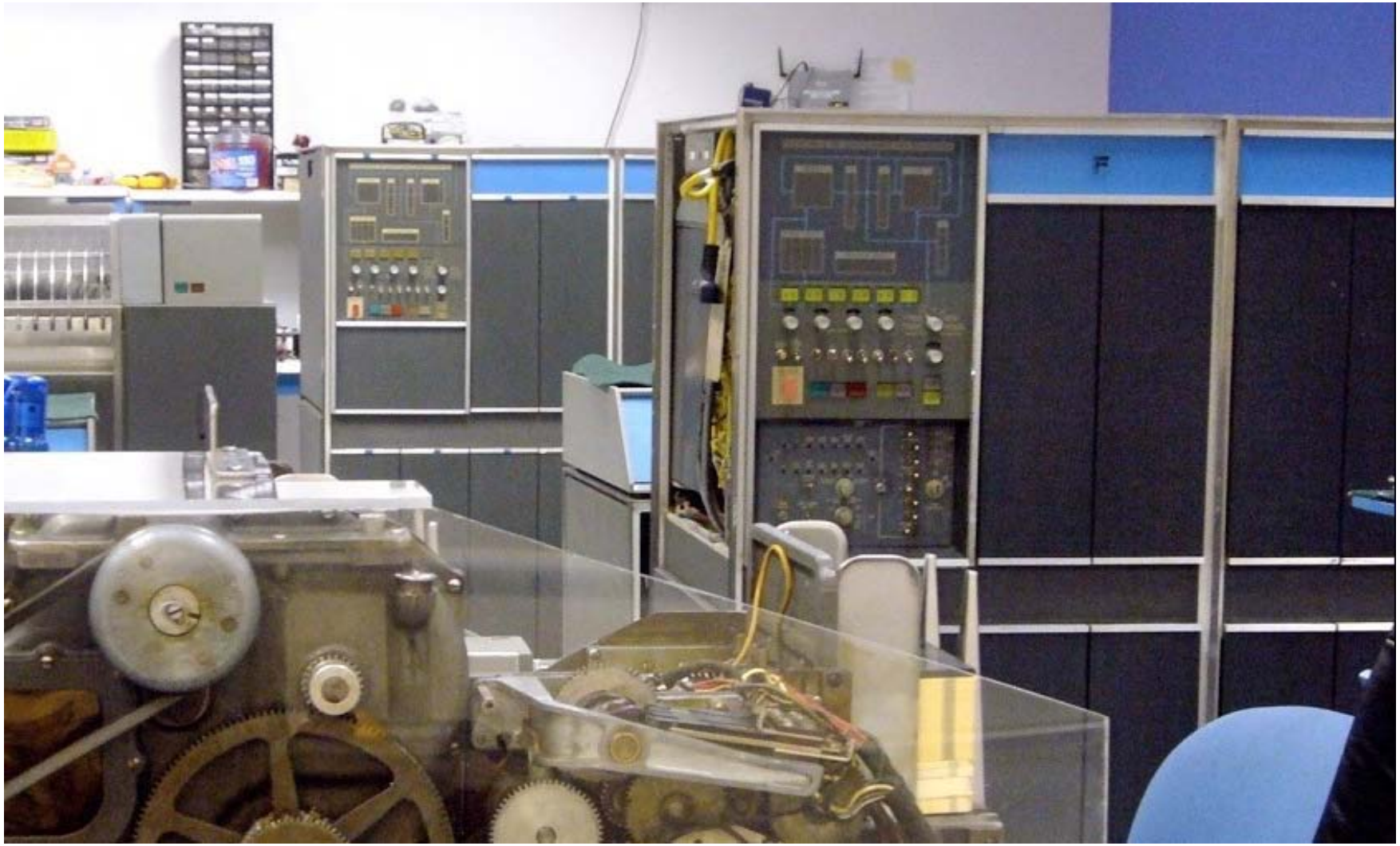
URL for the Computer History Museum is (www.computerhistory.org.)
Phone: (650) 810-1010
Location: 1401 Shoreline Blvd, at the intersection of Highway 101 in Mountain View.

Contact:
Robert Garner
(408) 927-1739
robgarn@us.ibm.com

Early restoration team (2004)

CT 1401, Darien, Connecticut (2008)

Two 1401s! (2008)



1401 restoration lab (2009)

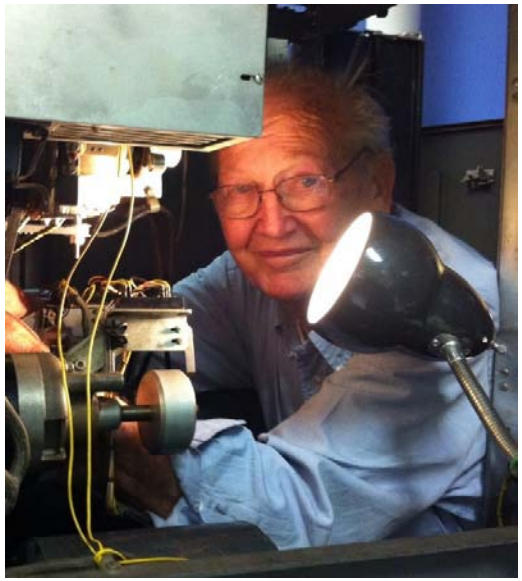
1401 full volunteer team (2013)

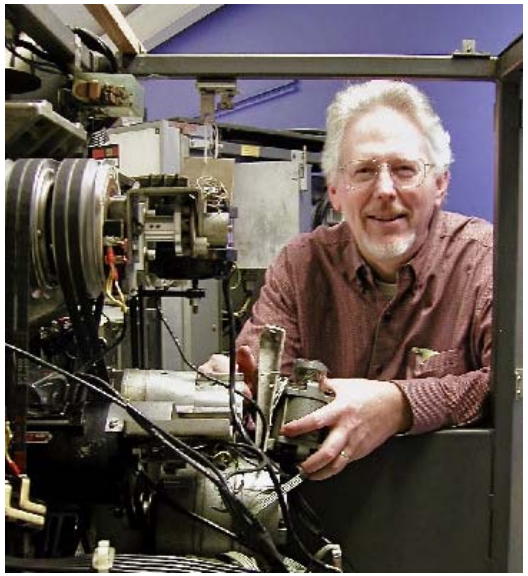
George Ahearn, Ron Williams, Bart Cotton, Frank King, Judith Heammerle, Bill Newman, Ed Thelen, Bob Erickson, Glen Lea, Robert Garner, Stan Paddock, Bill Worthington, Dave Lion, Don Luke, Joe Preston, Bill Flora, Ron Crane, Douglas Martin

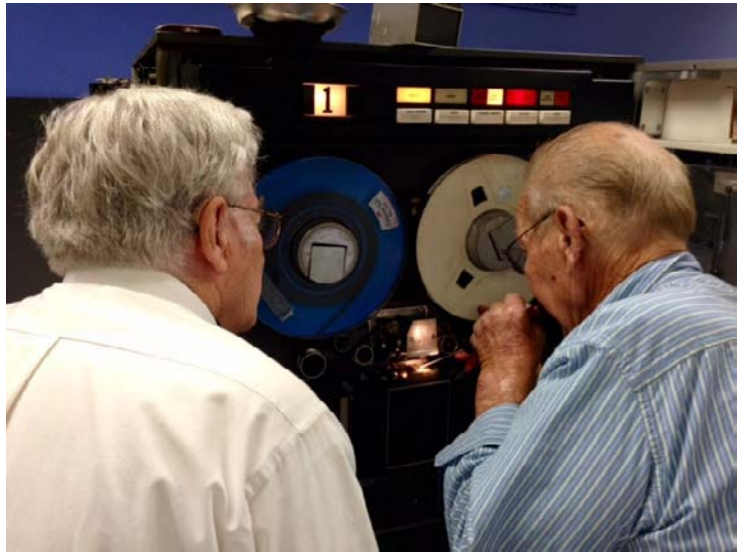
1401 Oral History Panel (2015)

Bill Flora, George Ahearn, Frank King, Allen Palmer, Ed Thelen, Iggy Menendez

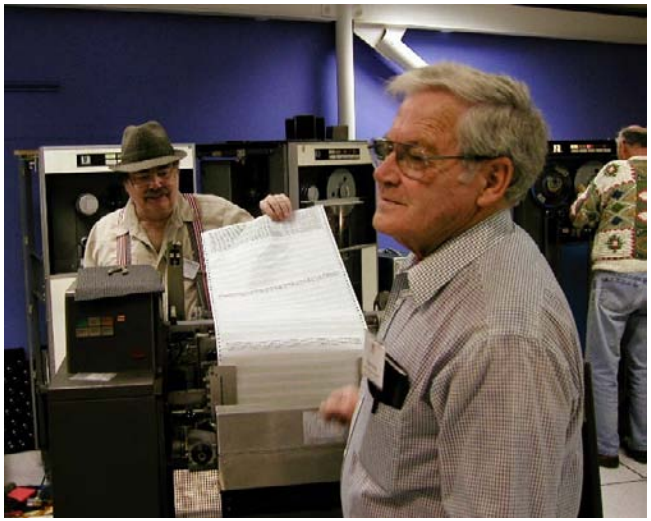
20,000+ volunteer hours



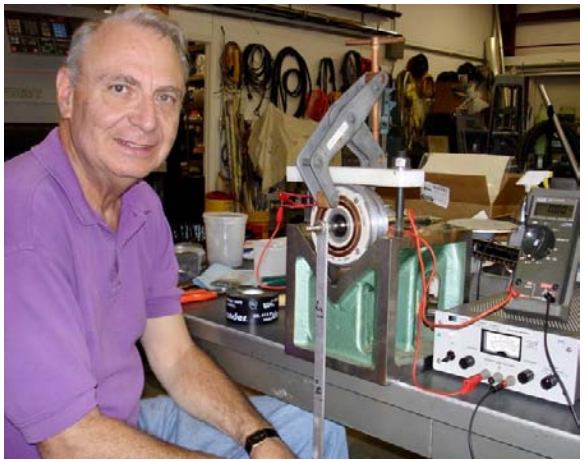


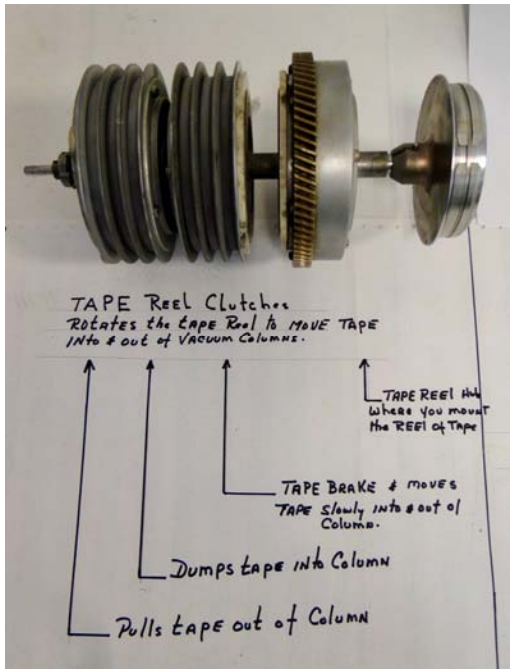


20,000+ volunteer hours



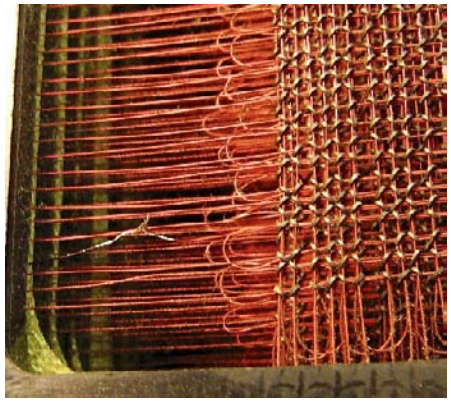
DE 729 tape drive refurbishment



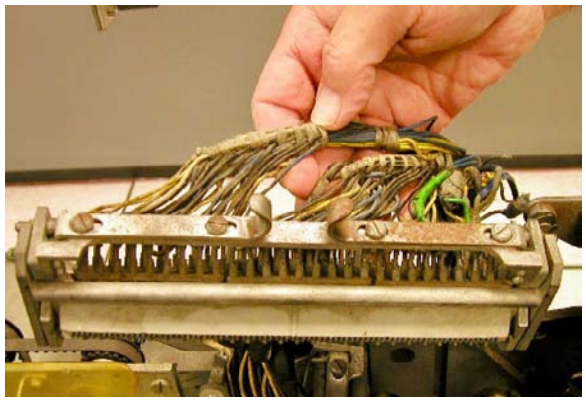


IBM 1402 (finiky) mechanicals

1401 faulty components & corrosion

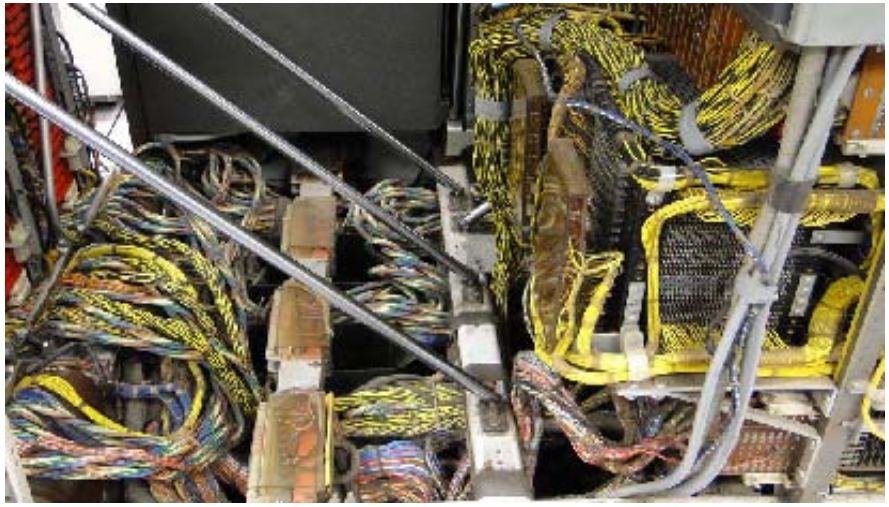


One broken core wire

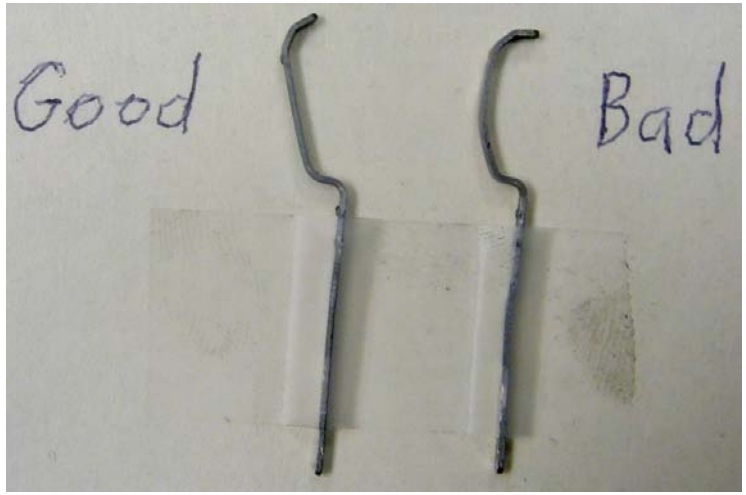


Corroded 1402 brush block

Several leaky capacitors

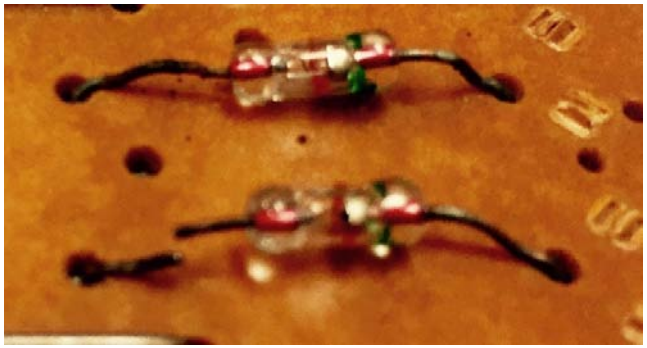


NO wiring or wire-wrap problems!

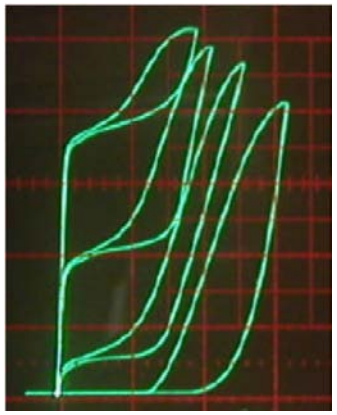


One faulty backplane connector

DE 1401 corroded “solid state” devices



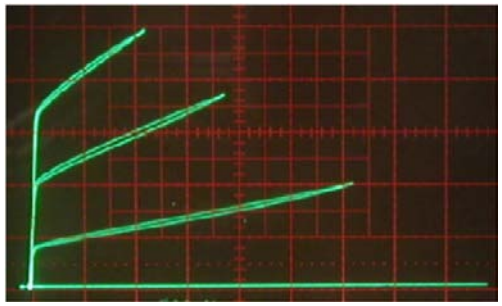
Rusted germanium diode leads



Loopy

I-V traces

OK



Bizarre “loopy” I-V germanium alloy-junction transistors (surface state contamination)

Rusted transistor caps & leads

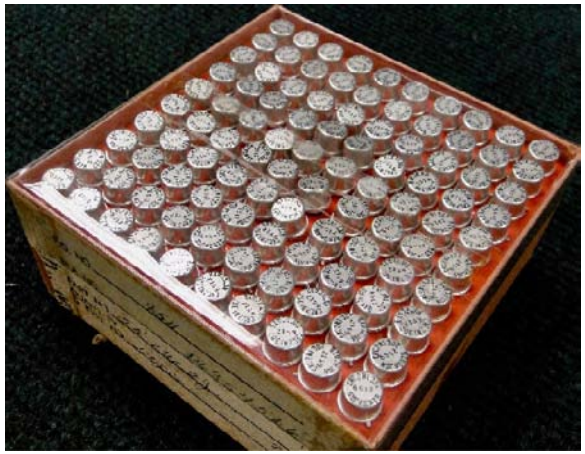
DE 1401: 117 faulty SMS cards

CT 1401: 30 faulty SMS cards

Given 3000 SMS cards per 1401:
Average annual failure rate =
1 per 2000 per year (0.05%)

1401 replacement parts & supplies

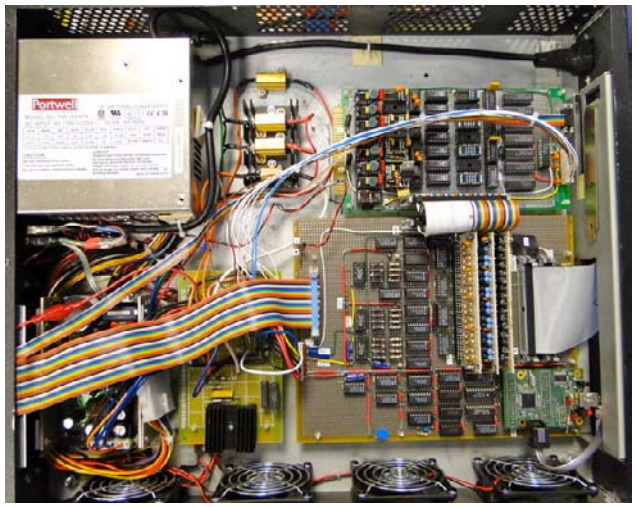
400,000 (un)punched cards

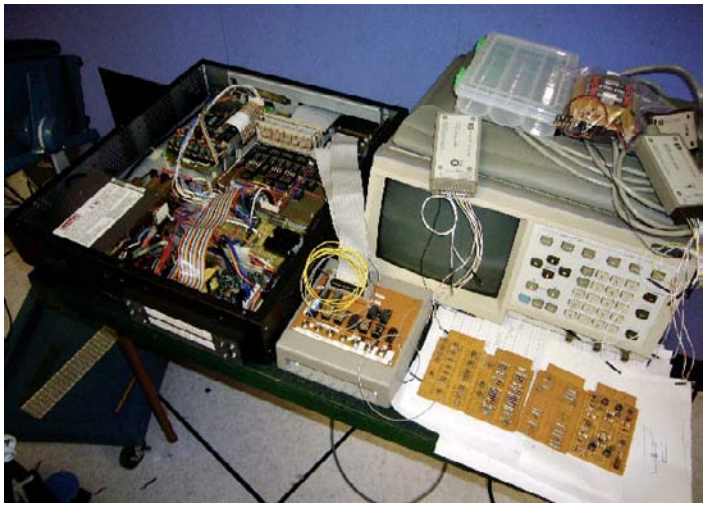


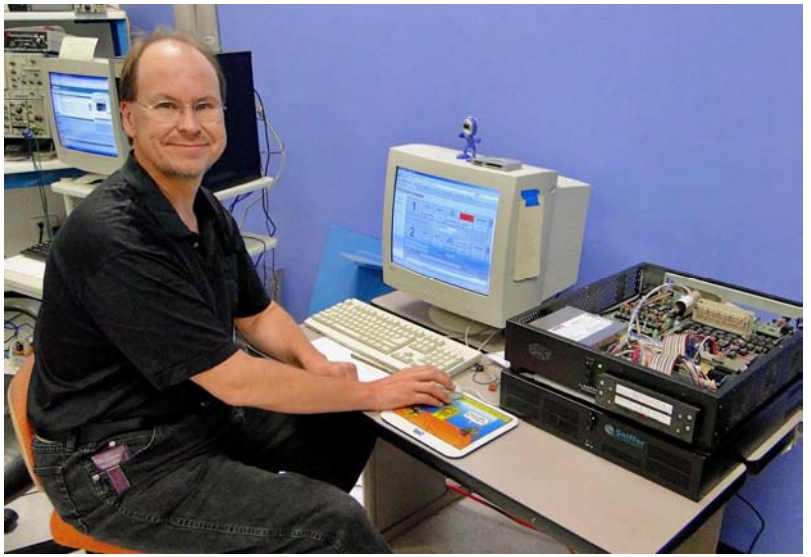
New-old-stock germanium transistors

Spare SMS printed-circuit cards

Custom 729 tape drive emulator







1401 programming group (2012)

Ed Thelen - BIG PRINT

Ron Mak - ROPE

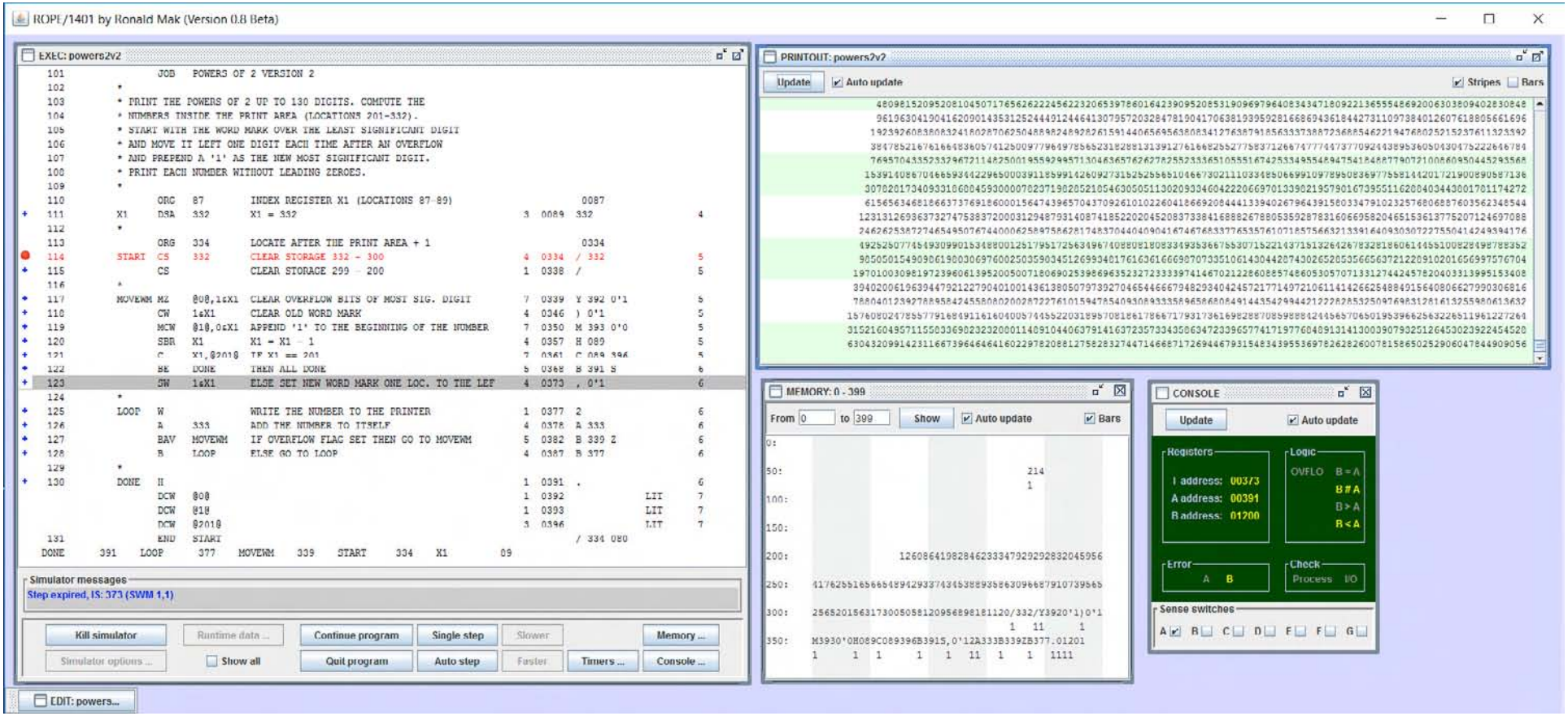
Van Snyder - Simulator & AutoCoder in ROPE

George Ahearn

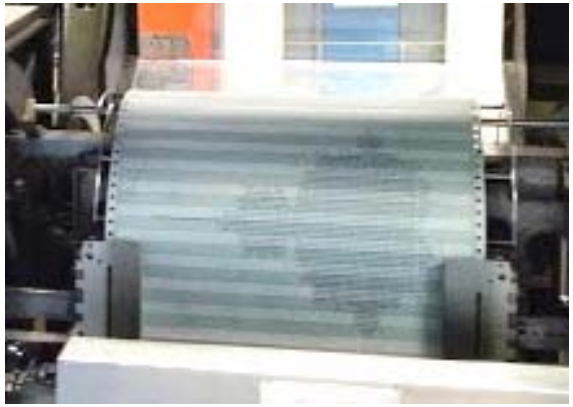
Bill Newman

Bob Feretich tape emulator

1401 Development & Simulation Environment (ROPE)



1401 modern programs



Mandelbrot Set

Ray tracing

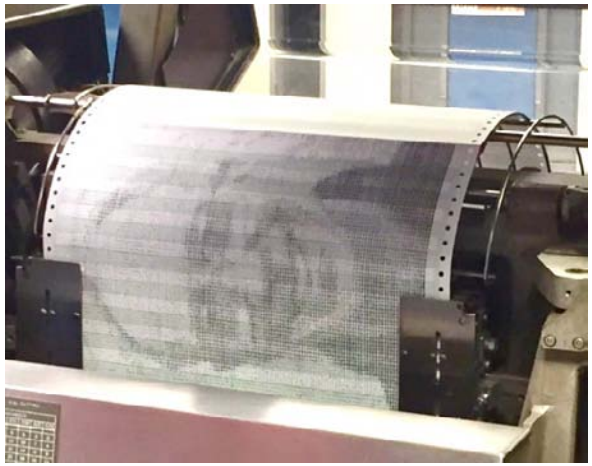
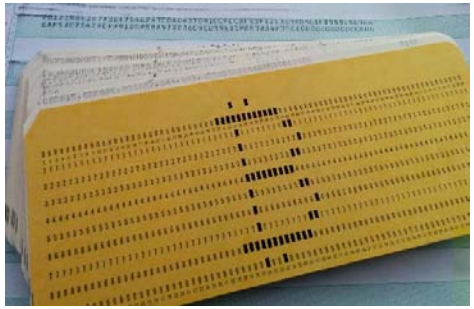


Photo-to-1403 overprinting



Bitcoin mining

At 80 seconds per double SHA-256 hash, a 1401 would require about 10^{14} years and 10^{18} US dollars of electricity to mine a single block of transactions, for a return of $ 6,000.

Bob Erickson (92)

IBM 1401

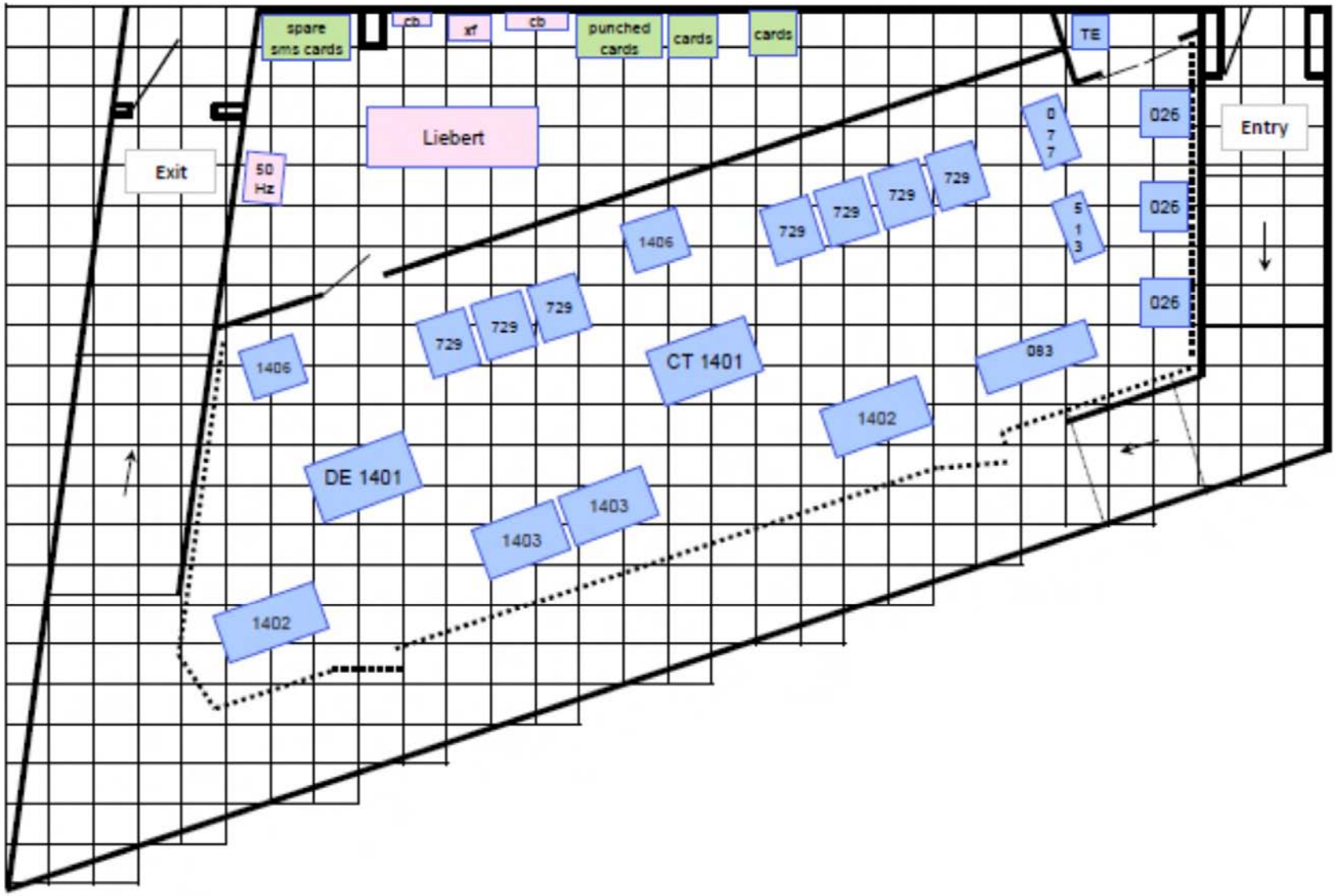
DEMONSTRATIONS

Demo Lab corridor

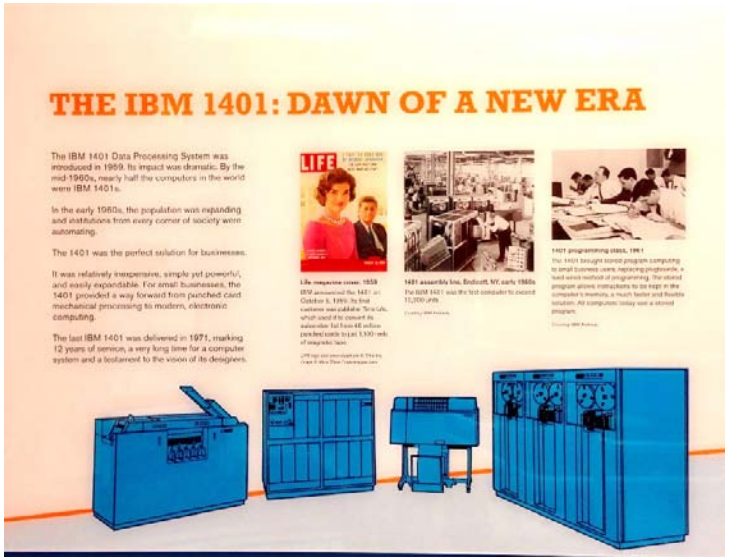
IBM 1401 vintage showroom (1960s)

IBM 1401 Demo Lab (2011)

1401 Demo Lab – floorplan



1401 Demo Lab – signage



1401 Demo Lab – entrance wall

1401 Demo Lab – entrance

1401 demos

1401 demos

1401 demos

1401 demo – school field trip days

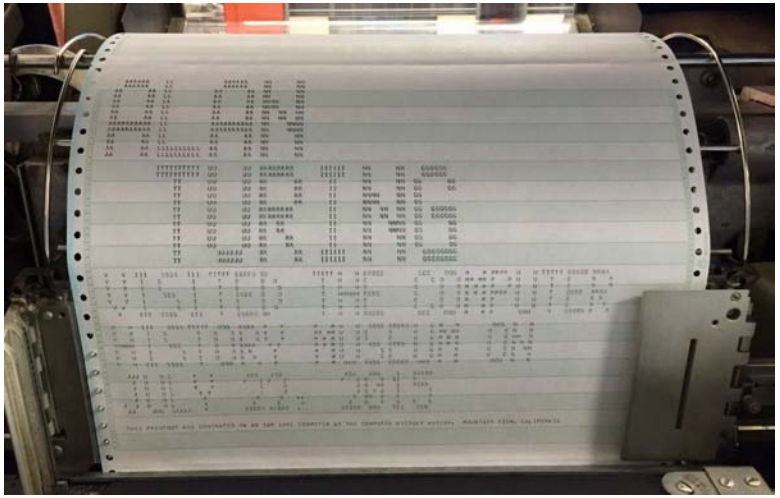
1401 demo – high school students

1401 demos – college CS students

1401 demo – special guest

Chuck Branscomb, directed development of 1401 (1957-60)

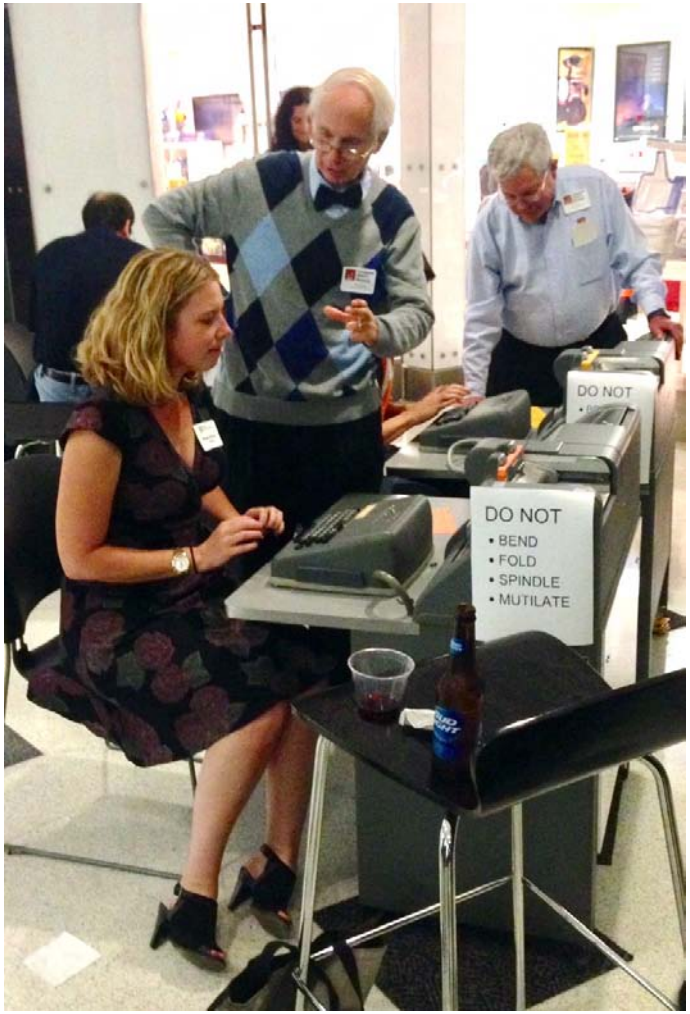
1401 demos – punched cards, props, …

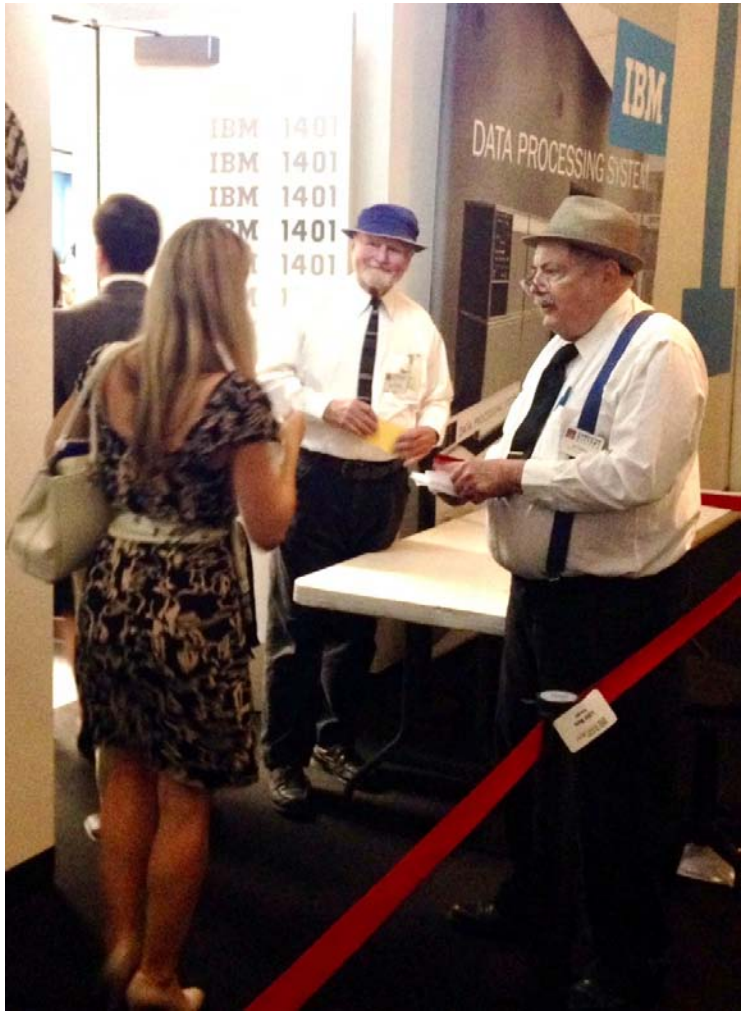


IBM 026 keypunches

IBM 001 hand keypunch

‘Young Professionals’ 1960s retro event





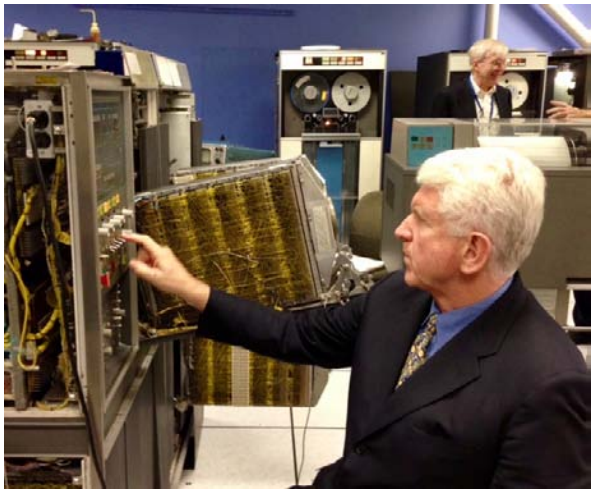
1401 ongoing maintenance

1401 ongoing maintenance

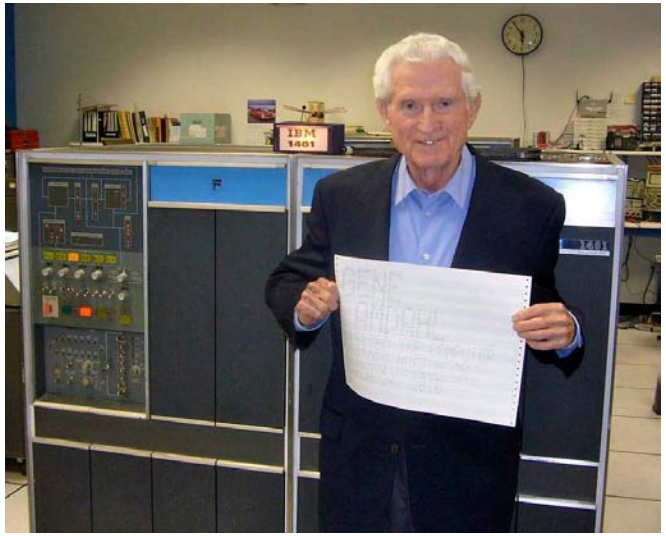
(Maker Faire, 2017)

1401 special visitors

Steve & Janet Wozniak



Bob Metcalfe



Gene Amdahl

Doug Englebart

Restoration Guidelines

- Safety first
  - Two people must be present when equipment is open and energized.
  - CPR and first-aid training
- Historical integrity & authenticity
- Reversible alterations
- Record/log restoration actions
- Restoration policy:
  - Objectives, criteria, logistics, liaison

Ingredients for success

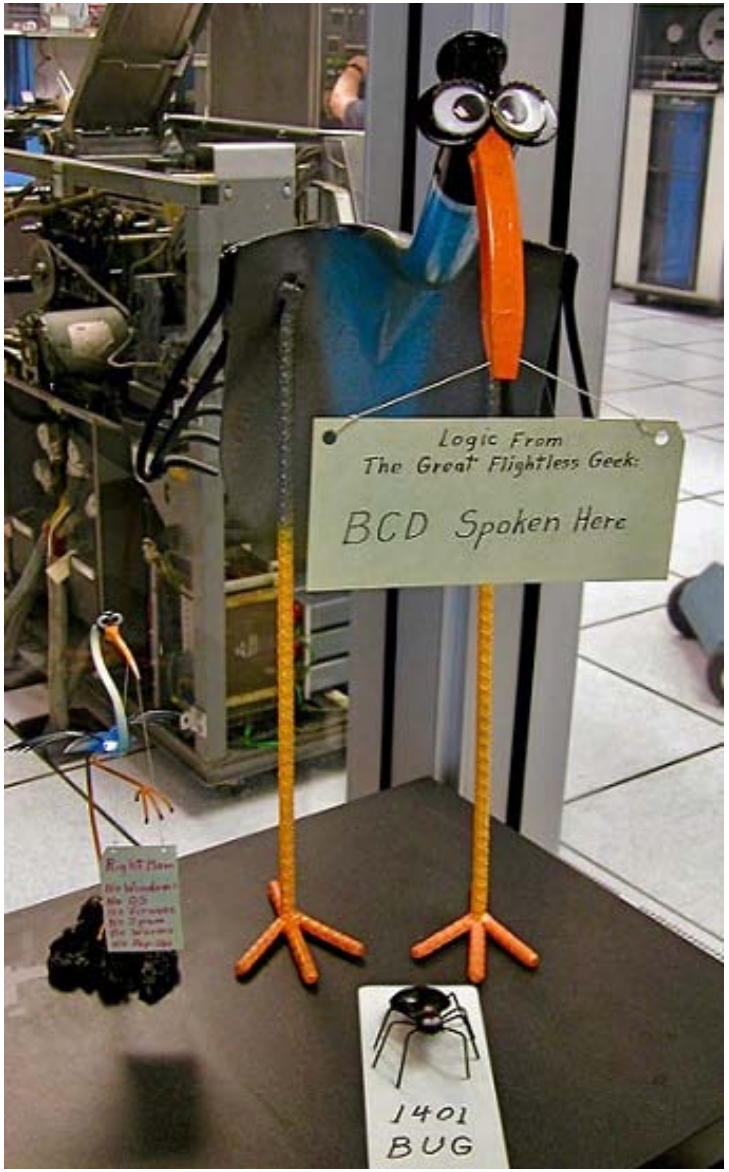
- Compelling demo!
- Pool of volunteers
- Light-hearted temperament & comradery
- Engaged museum liaison
- Two systems – if possible
- Workshop – nearby
- Web scribe and documentarian
- Demo training – lead & assistant

Measured pace

“Unlike normal high-tech endeavors, where the longer it takes the less valuable the product, with computer artifact restoration projects, the longer it takes the more valuable the outcome.”

– R. Garner

Light-hearted temperament



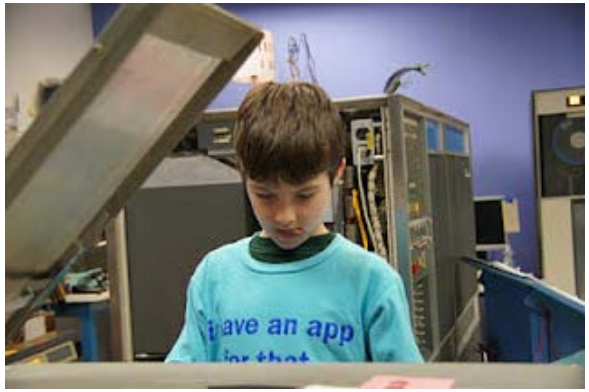
Comradery

Restoration workshop

Why restore vintage computers?

- Deepens museum's presentation and interpretation of computing history
- Enriches visitors' experience
- Bolsters museum's educational mission
- Illustrates the fundamentals of computers
- Creates authentic "time-machine" experience
- Seeing how far technology changed in fifty years, visitors may contemplate what computing will be like in the next half century.

Why demo vintage computers?



Why demo vintage computers?