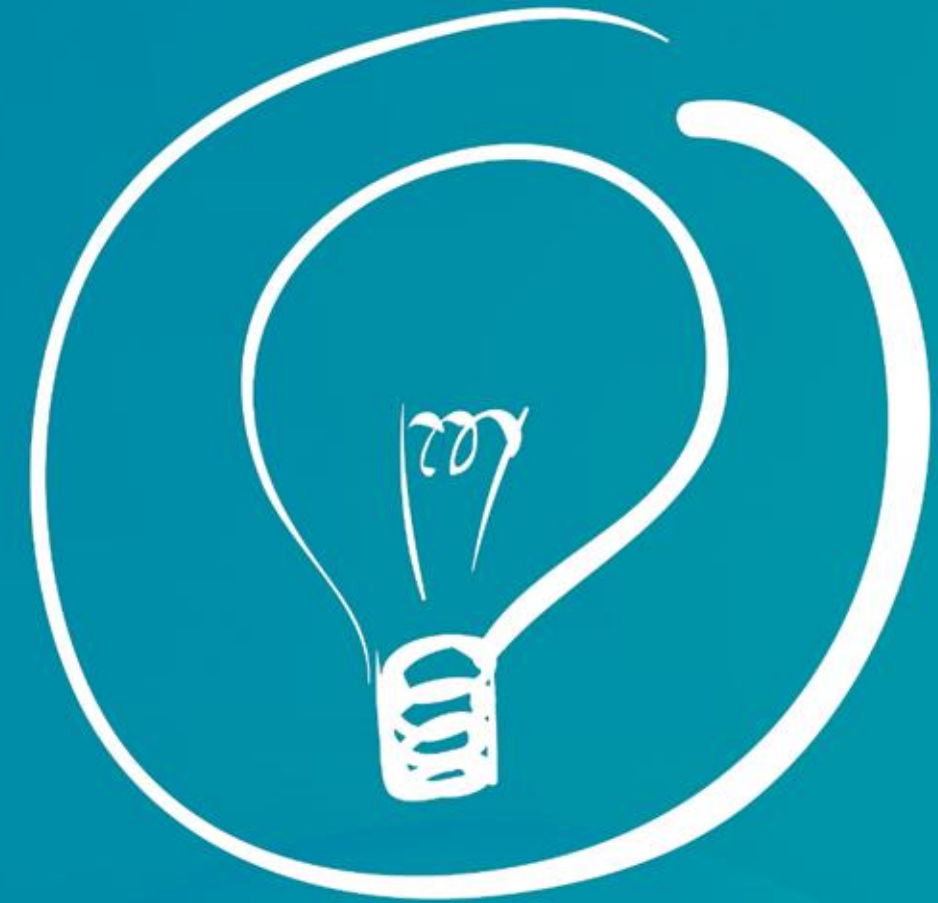


# VANGUARD SECURITY & COMPLIANCE 2024

## The IBM® System/360®

The 'Bet your Business' Gamble that  
Transformed the Information  
Technology Industry

Mark Nelson, CISSP®, CSSLP®  
Senior Technical Staff Member  
IBM



**KNOWLEDGE**  
is your best defense

# The IBM System/360

The 'Bet your Business' Gamble that  
Transformed the Information Technology Industry

Mark Nelson, CISSP®, CSSLP®  
Senior Technical Staff Member  
z/OS® Security Server (RACF®) Design and Development  
IBM® Poughkeepsie  
[markan@us.ibm.com](mailto:markan@us.ibm.com)

VSC-2024





# Why are we here?

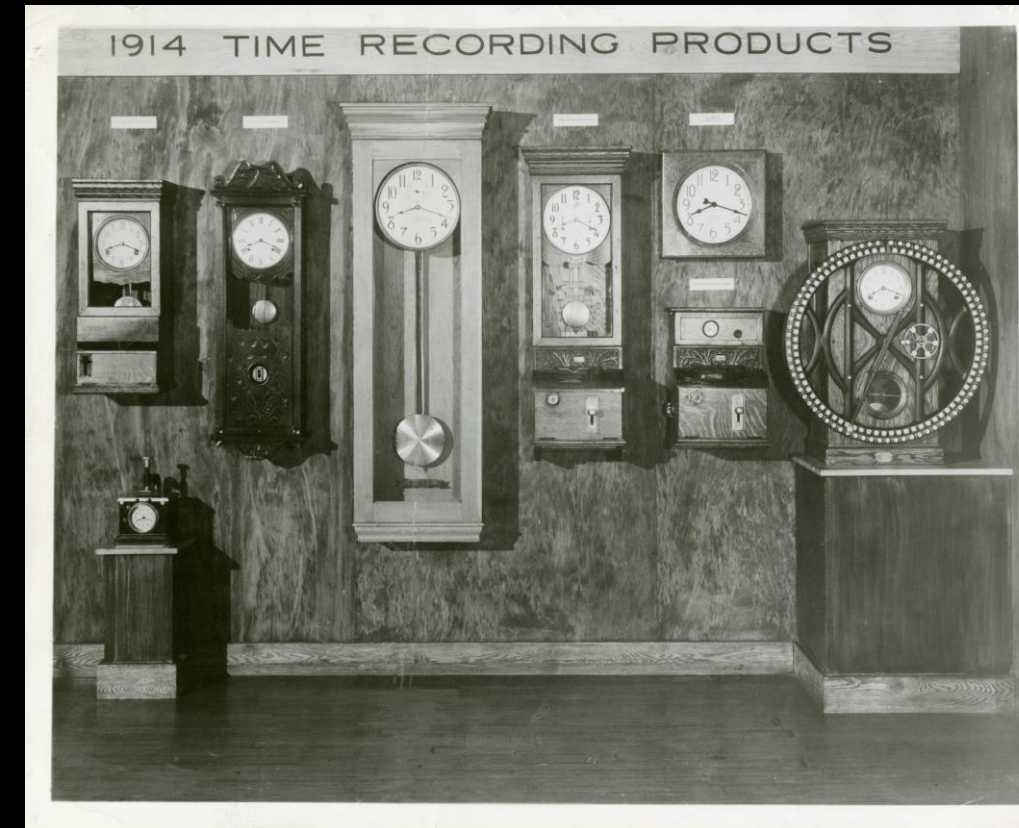
- **IBM's announcement of the IBM System/360 on Tuesday, 7 April, 1964 was an inflection point for the information technology industry.**
- **With its consistent architecture across the line of products, the System/360 enabled the unprecedented growth of both the computer hardware and software industries.**
- **This session explores the history and effects of this announcement.**





# For this session...

- Ask questions *at any time!*
- *All of this is strictly my opinion.*





# Why am I here?

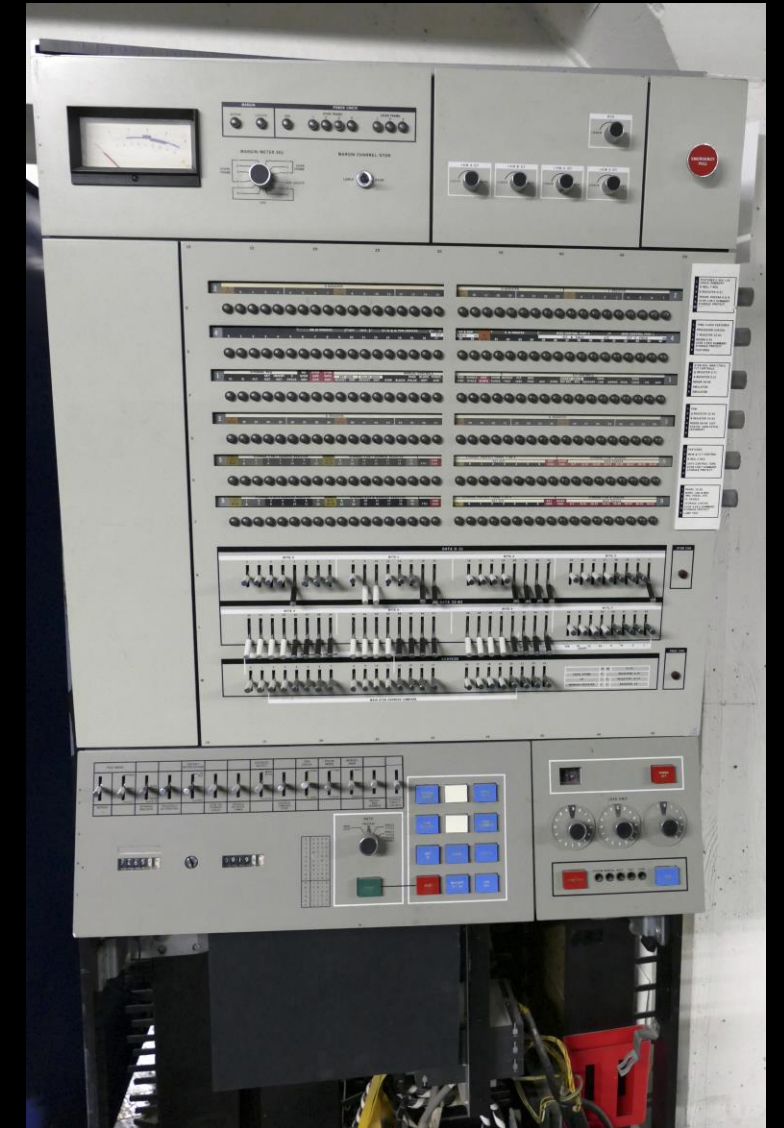
A guy never forgets....



His First Car



His First Love



His First Computer

# My First Real Computing Job was on this!

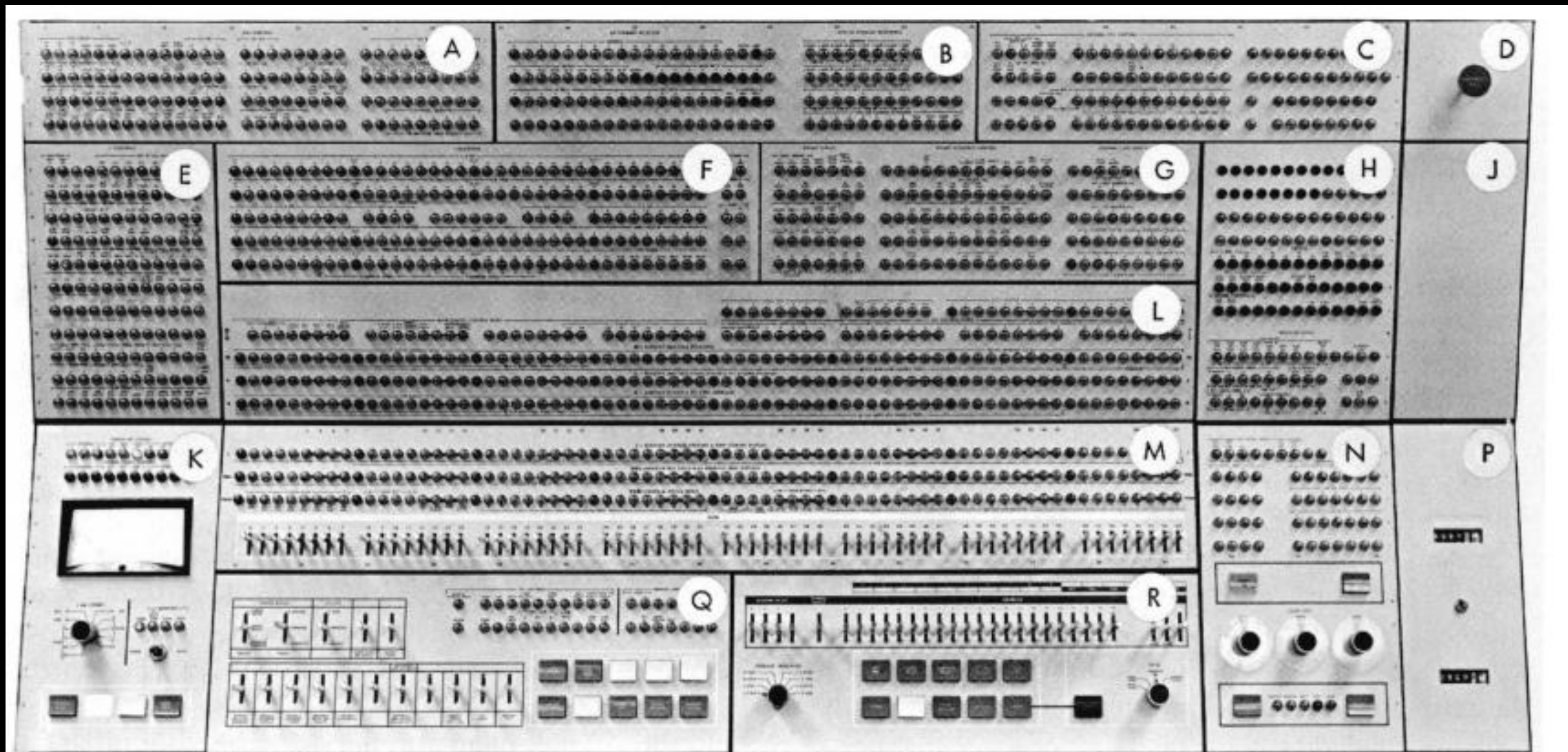
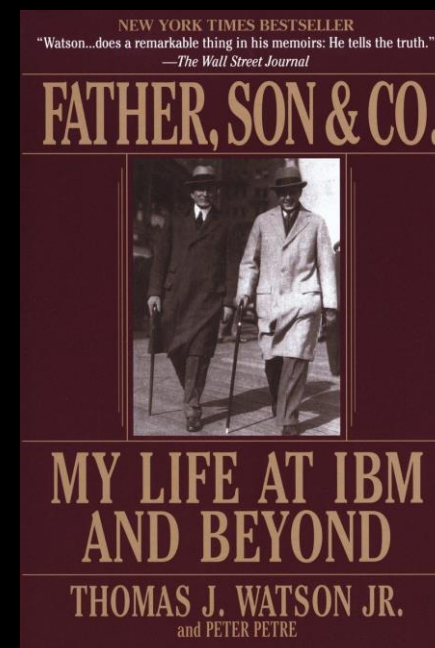
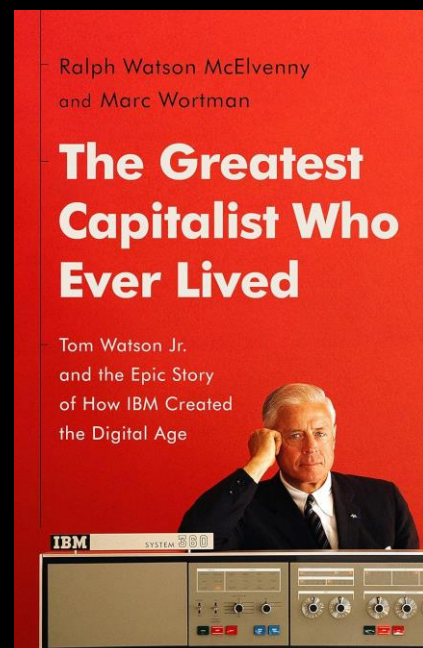


Figure 5. System Control Panel, Model 75

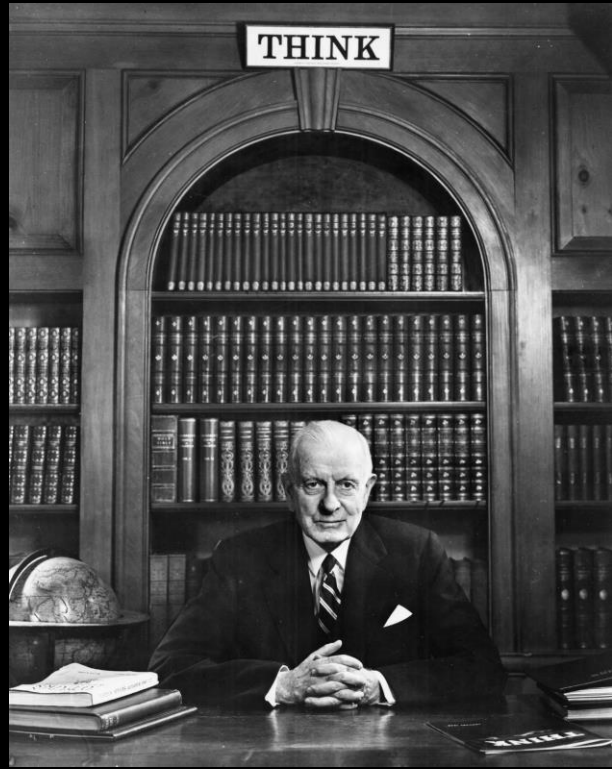


# For More Information...



- **Bob O. Evans, *The Genesis of the Mainframe***  
<https://www.informatik.uni-leipzig.de/cs/Literature/History/boevans.pdf>
- **The IBM System/360**  
<https://www.ibm.com/history/system-360>
- **The Final Report of the SPREAD Task Group**  
<https://archive.computerhistory.org/resources/access/text/2011/10/102713231-05-01-acc.pdf>
- **Bitsavers.org**

# Key People in our Story (A Very Incomplete List)



**Tom Watson, Sr.**



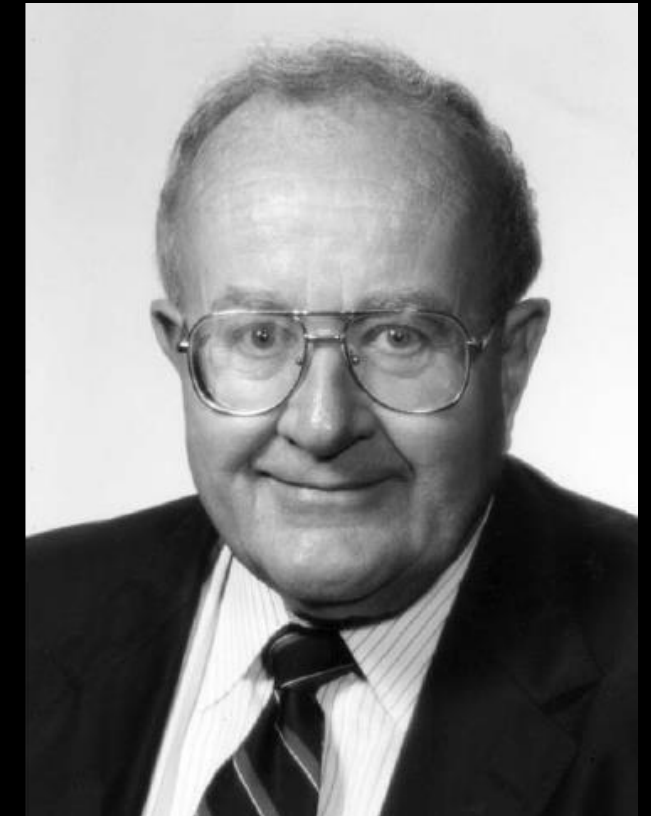
**Tom Watson, Jr.**



**T. Vincent Learson**



**Fred Brooks**



**Bob O. Evans**

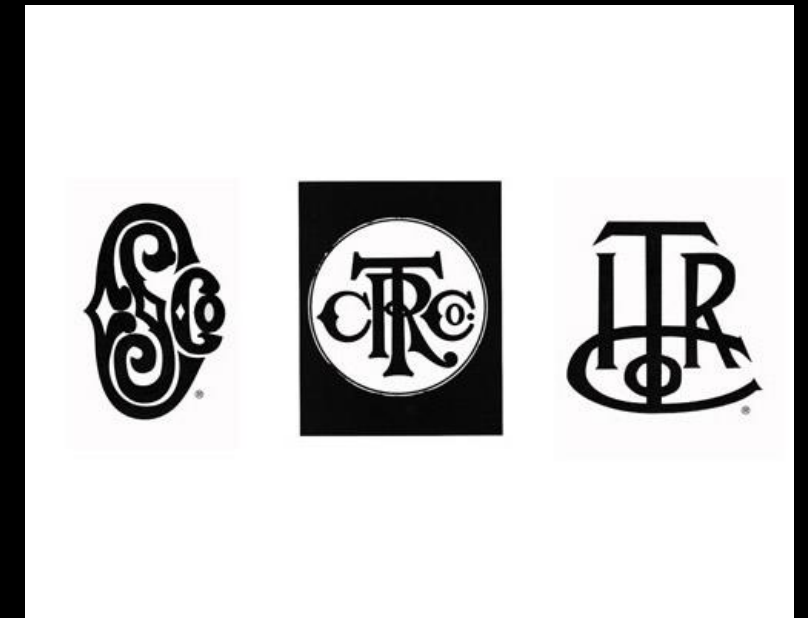
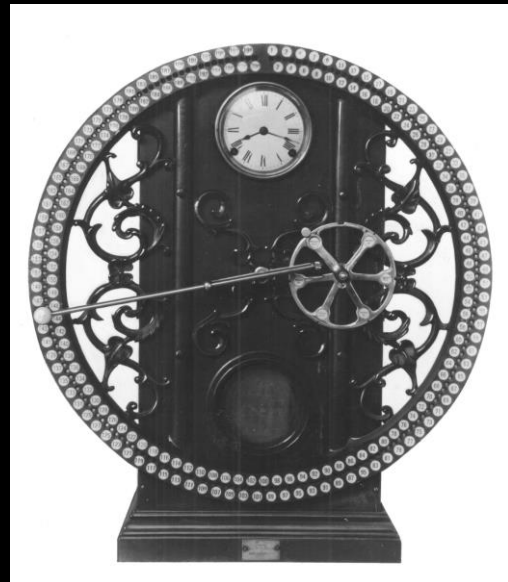


**Gene Amdahl**



# It's All About Business

- No matter what IBM was producing, its activities were focused on one thing: *Business*

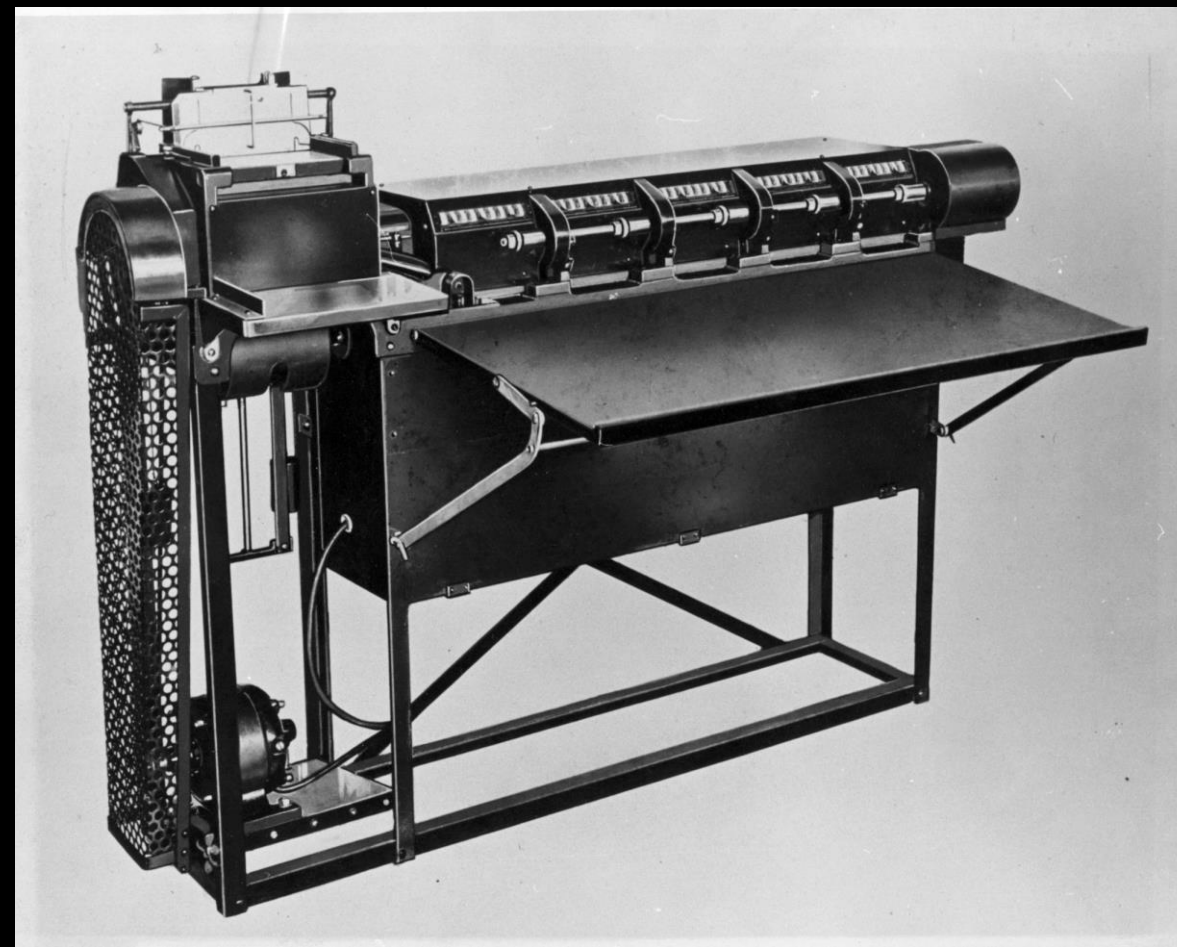




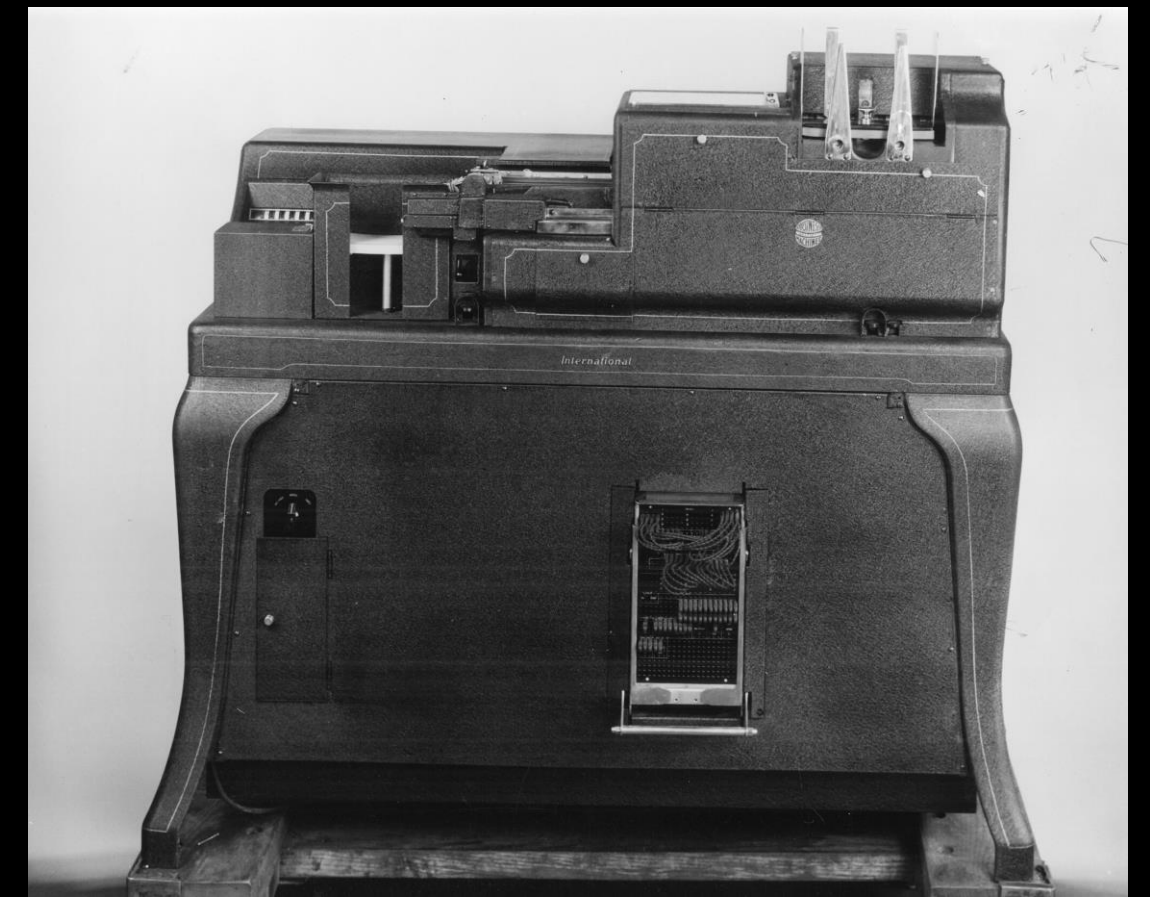
# IBM's Consolidation on Electro-Mechanical Computing



Hollerith Tabulator/Sorter



IBM Model 93



IBM Model 601



# IBM SSEC: Moving to Electronic Computing

- **The IBM Selective Sequence Electronic Calculator (SSEC)**
  - Based on the electro-mechanical IBM Automatic Sequence Controlled Calculator (Harvard Mark I).
  - Built at IBM Endicott, installed at 590 Madison Avenue, NYC
  - Electronic and electromechanical design
  - Arithmetic unit: Approximately 12,500 vacuum tubes were used in the arithmetic unit, control, and its eight high-speed registers, which had an access time of less than one millisecond.
  - Control and slow speed registers: Consisted of 21,400 relays with an access time of 20 milliseconds.
  - Calculated position information of the moon and planets; This data was the basis for data used later during the Apollo program



# IBM's Success In Electronic Computing

- 701 Series: 701, 704, 709, 7090, 7040, 7044, 7094 I, 7094 II
- 702 Series: 702, 705, 7080
- 650 Series: 650, 7070, 7074, 7072
- 1401 Series: 1401, 1410, 1440, 7010, 1460
  - 1401 was wildly successful; First to sell 10,000 units
- Others: NORC, SAGE, RAMAC, Stretch(7030)





# IBM: Beginning of the 1960s

- IBM had five different product lines with five different architectures
  - Different software
  - Different attached devices
- Movement of applications and data across product lines was difficult as was movement within a product line
- Supporting client's growing needs was difficult

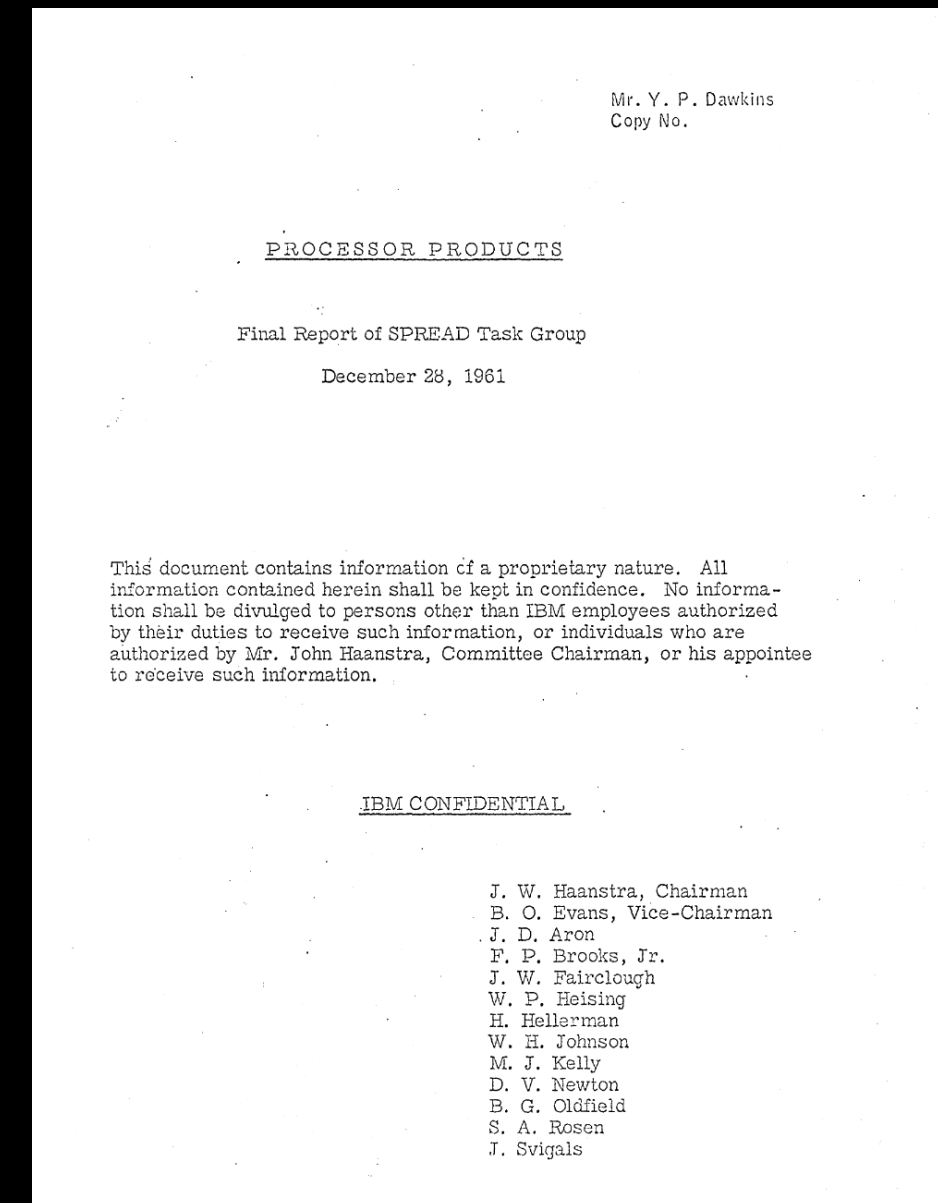


What's next?

# The SPREAD Task Group

- The SPREAD (Systems Programming, Research, Engineering and Design) task force formed in 1961 to address these issues:

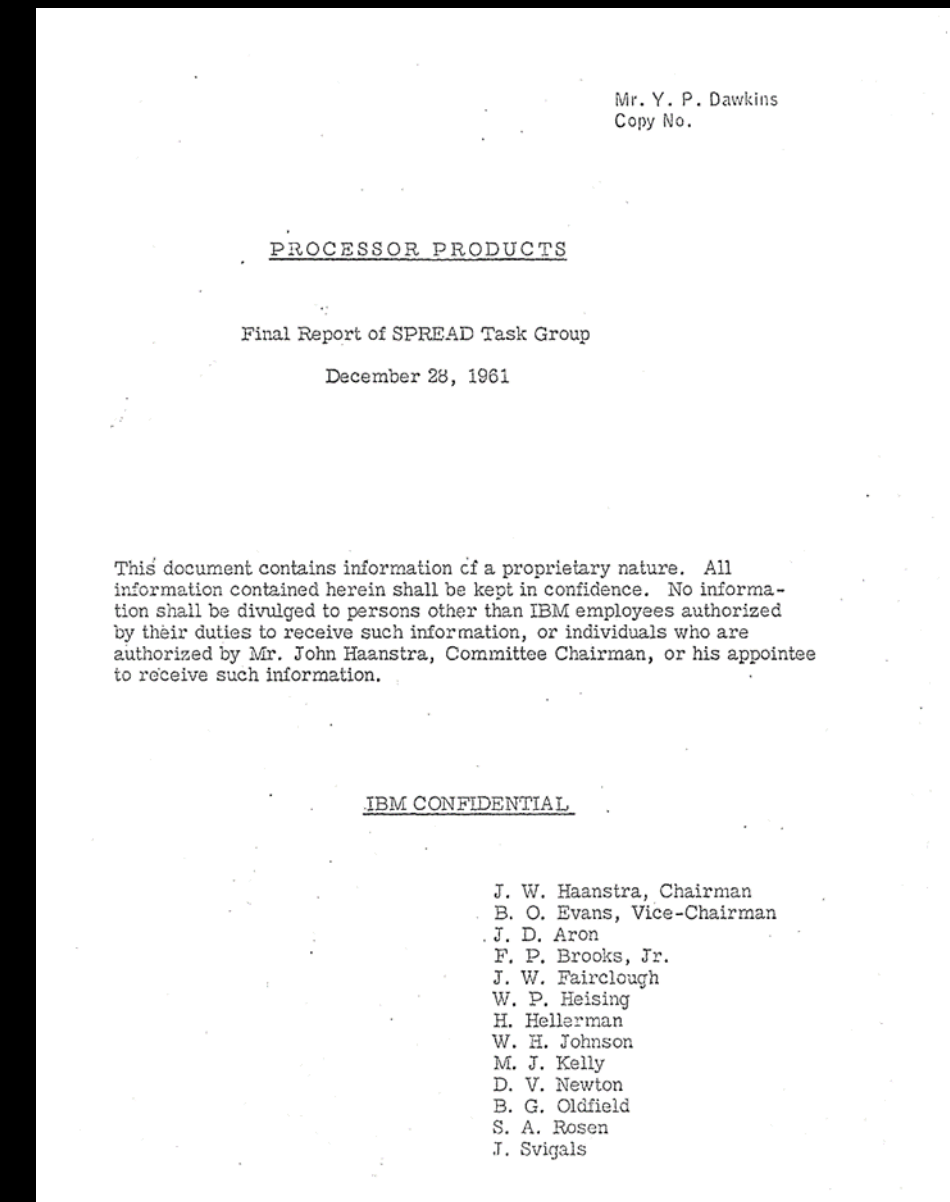
- The incompatible architectures and the related hardware, software, and support issues
- The impossibility of designing common input/output (I/O) devices
- The need to drastically grow capabilities in related technologies, such as memory and external storage
- The limitations of the current internal representations of characters
- A management structure to make it all happen





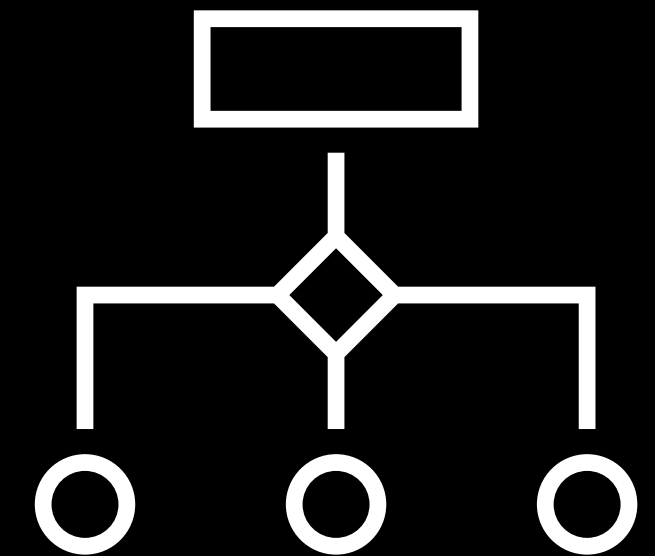
# The SPREAD Task Group Report

- The SPREAD described the development for a New Product Line (NPL), which would:
  - Be a family five systems
  - Handle both scientific and business applications
  - Have a performance ratio of 1 to 200
  - Have basic communications facilities and event handling
  - Provide upward and downward compatibility among the family members
  - Be incompatible with all of the existing systems



# An Organizational Challenge

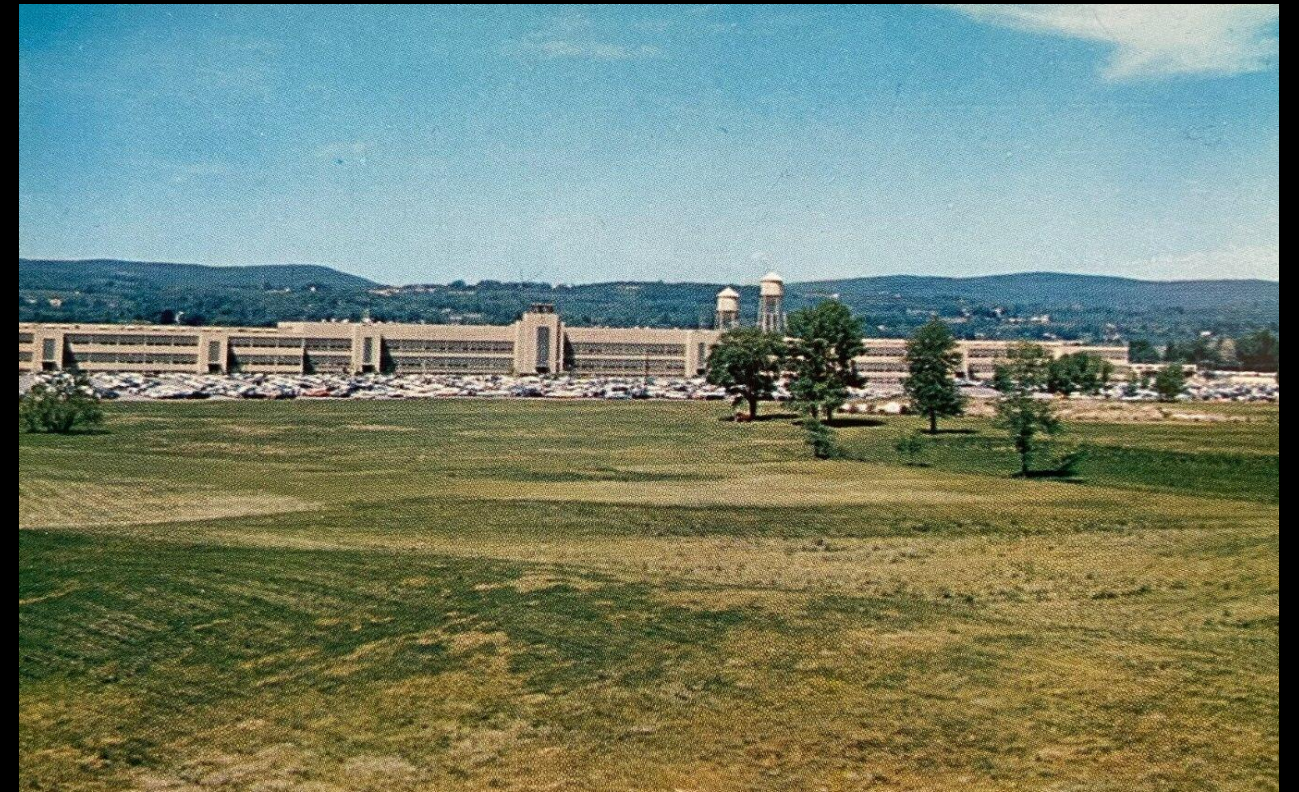
- **IBM had several separate organizations responsible for providing products to the marketplace:**
  - The Data Systems Division (DSD), responsible for systems which rented for 10K\$US or more per month or more.
  - The General Products Division (GPD), responsible for systems which rented for less than 10K\$US per month.
  - The World Trade Corporation (WTC), responsible for developing systems for the “overseas” markets.
  - Federal Systems Division (FSD), responsible for systems sold to the US government. Created “hardened” systems and “one-off” systems.





# The SPREAD Report...

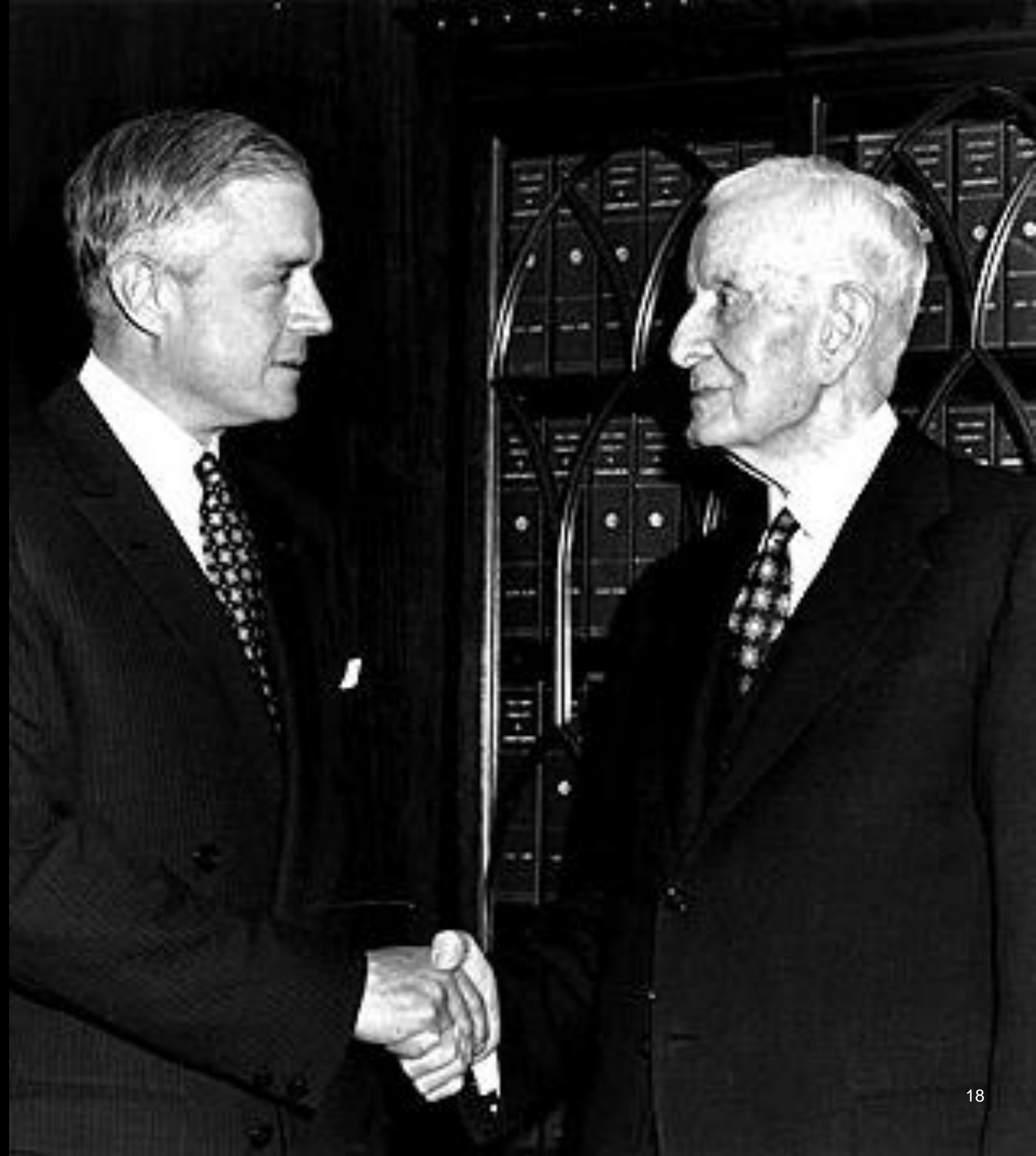
- **The Corporate Processor Control (CPC) was given responsibility for creating the architecture**
  - Established in the Data Systems Division in Poughkeepsie
  - Why Poughkeepsie?





# Father and Son

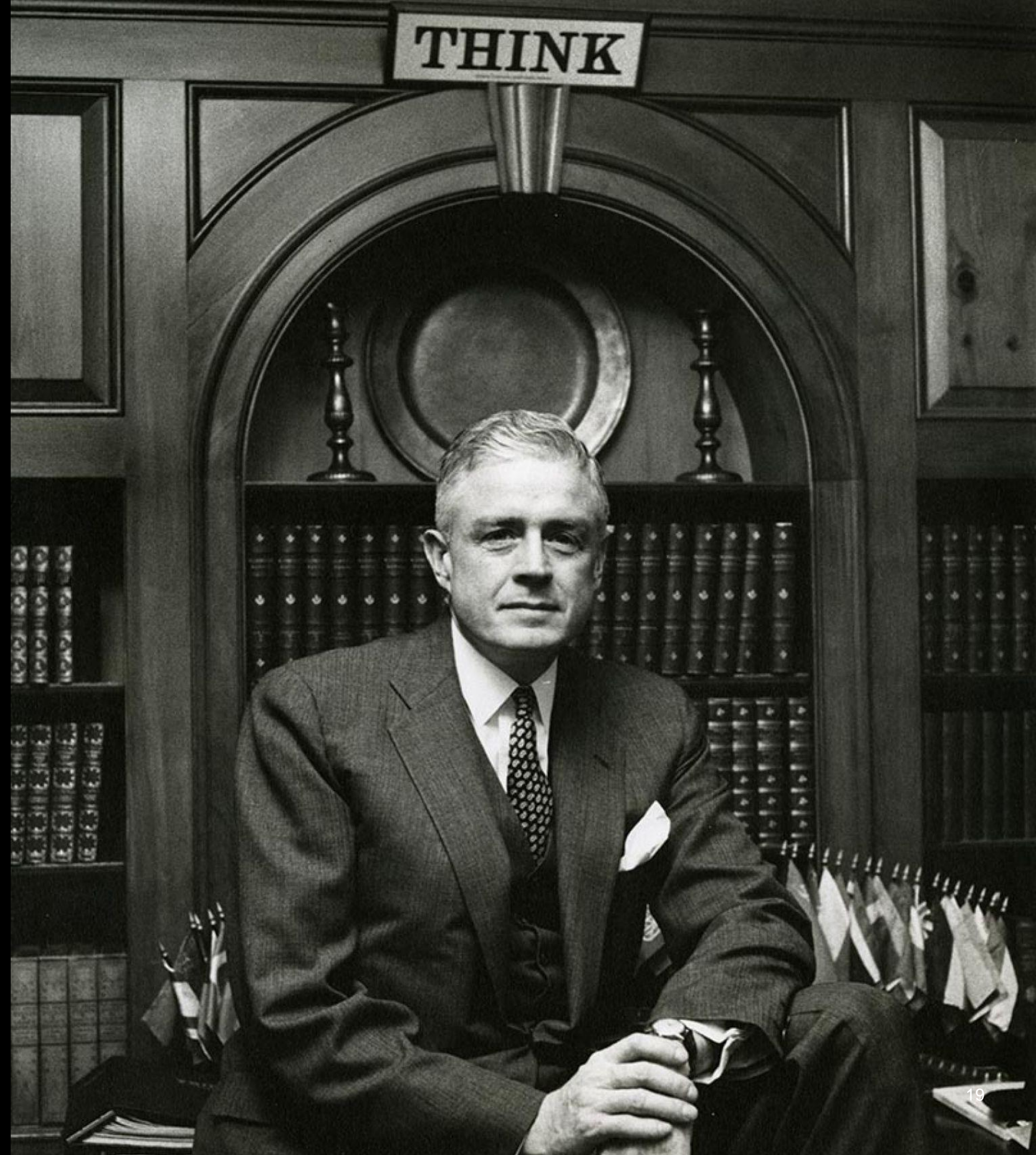
- **Tom Watson, Sr. set IBM on its course of client service and respect for the individual.**
- **In his earliest years, Tom Watson Jr. was rebellious and resented being expected to following in his father's footsteps.**
- **Tom's experience as a pilot in WWII drastically changed his attitude.**
  - Tom dedicated "*Father, Son, and Company*" to "Major General Follett Bradley, who gave me confidence"
- **Tom returns to IBM and leverages his military experience with electronics. In 1956, Tom Watson Sr. handed over the leadership responsibilities to his son, Tom Watson, Jr.**
- **Tom Watson Jr. often reflected on his performance at IBM, comparing it to his father's.**





# Tom Watson on Poughkeepsie

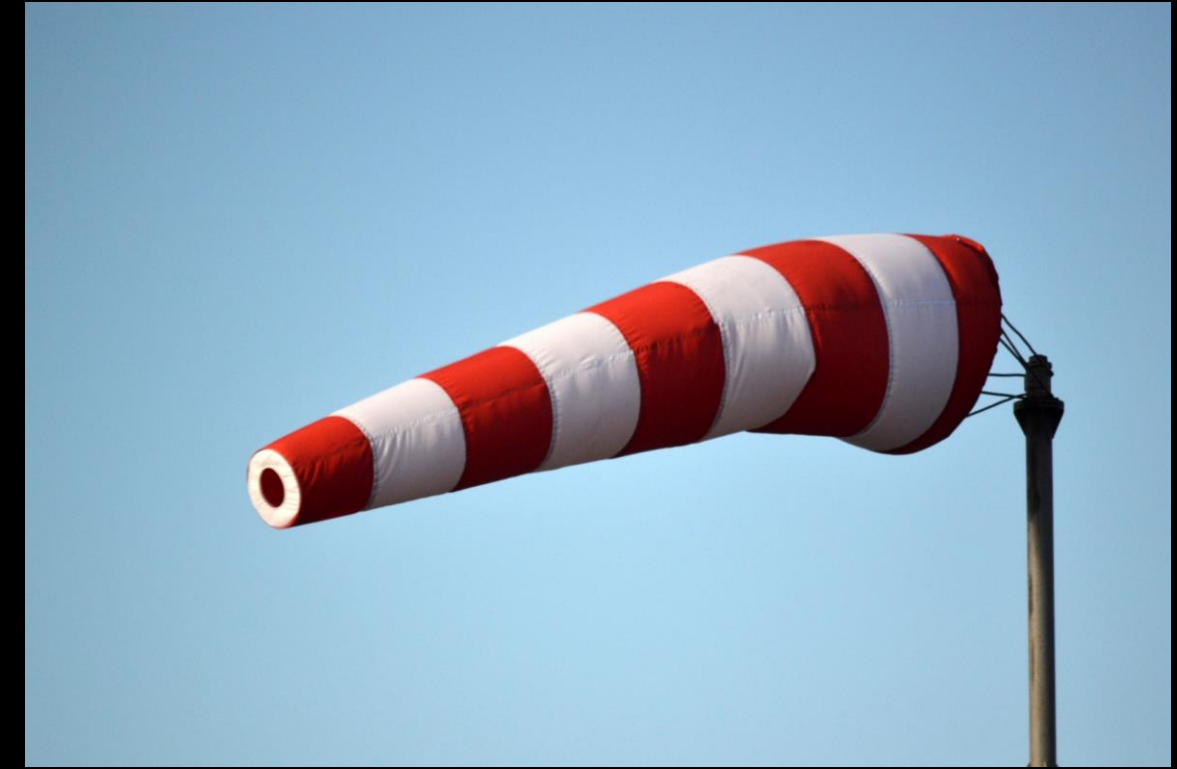
- **“You only had to to visit Poughkeepsie to get a sense of the fundamental change taking place in engineering. Our laboratory back in Endicott had always felt to me like a stuffy museum – a place where ideas were scarce and had to be jealously guarded and preserved. But Poughkeepsie was wide open – the ideas seemed as abundant as air, and you had the impression of a limitless future.”**
  - Tom Watson, Jr. *Father, Son, and Co., My Life at IBM and Beyond*, P.206





# Headwinds...

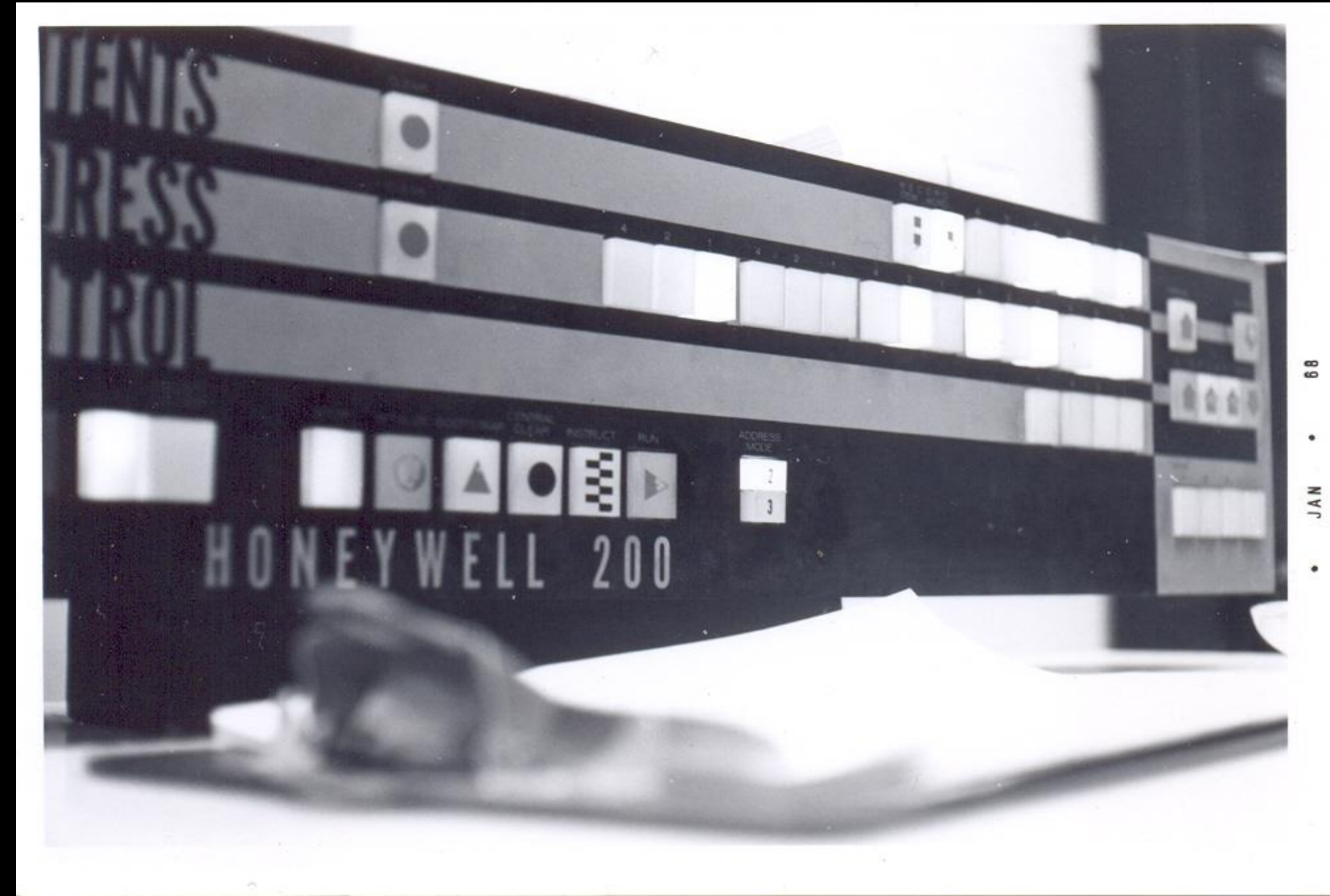
- **The shift to the NPL meant diverting resources from existing planned enhancements to the NPL**
  - DSD wanted to deliver its next generation system, the 8000
  - GPD wanted to enhance the very popular and successful 1401
  - WTC (UK Hursley) wanted to ship a small scientific computer, code-named SCAMP.
    - Suppliers could not keep up with IBM's needs
    - Software development was in its infancy





# Headwinds: Competition

- **Honeywell announces its pursuit of IBM clients with the its H-201 computer,**
  - The H-201/Liberator could run 1401 programs
  - 3 x the memory, lower cost
  - IBM loses 192 customers in 2 months
  - GPD plans to ship an upgraded 1401 (1401S) - This threatened NPL unity
  - Solution: Emulation! Based on SCAMP technology allowed the emulation of a1401 on smaller 360 machines, 7080/7090 on larger machines
  - 1401S is canceled



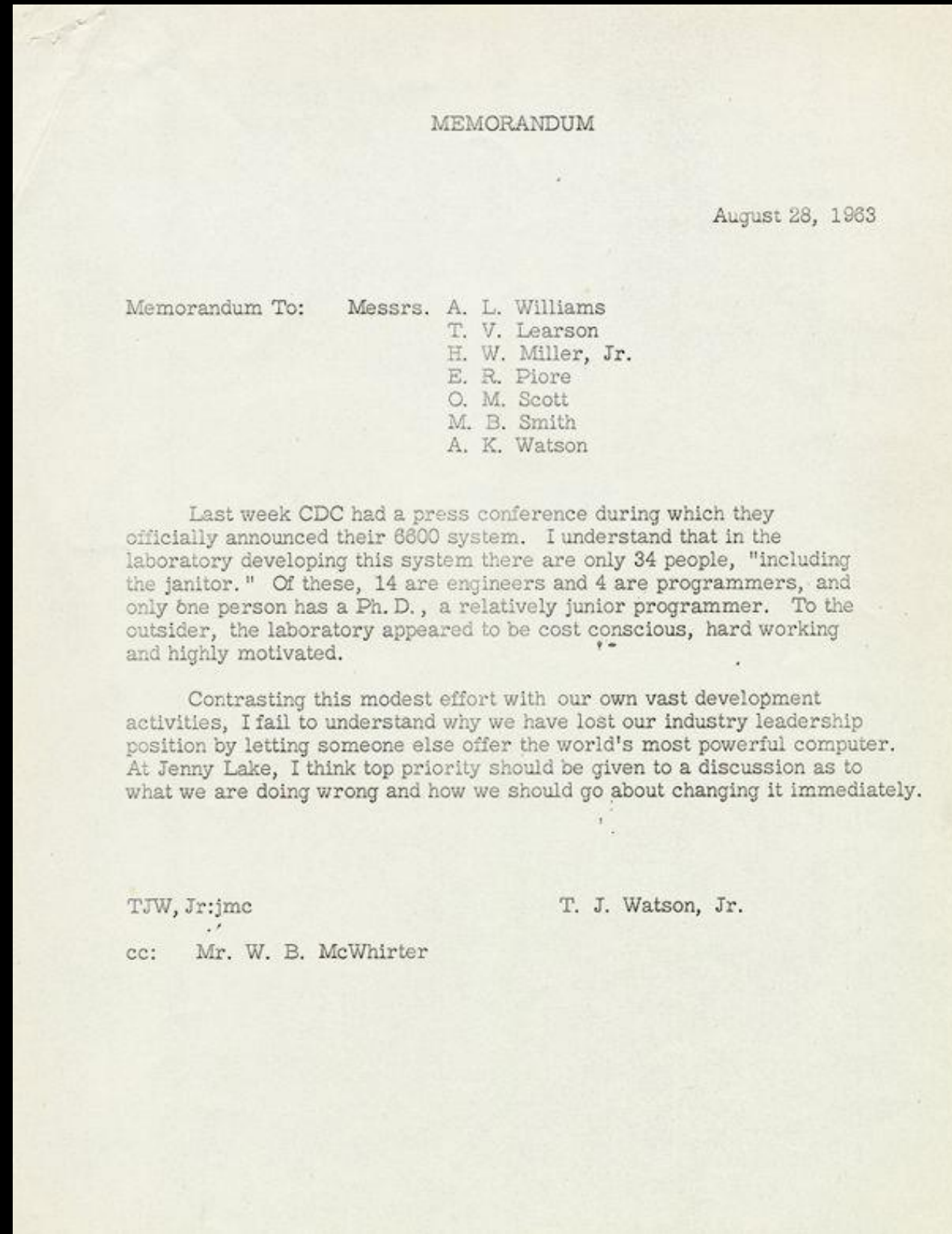
# Headwinds: Competition...

- **Control Data Corporation announces the world's fastest computer, the CDC 6600**
  - » Tom Watson's reaction was swift





# The “Janitor Memo”



August 28, 1963

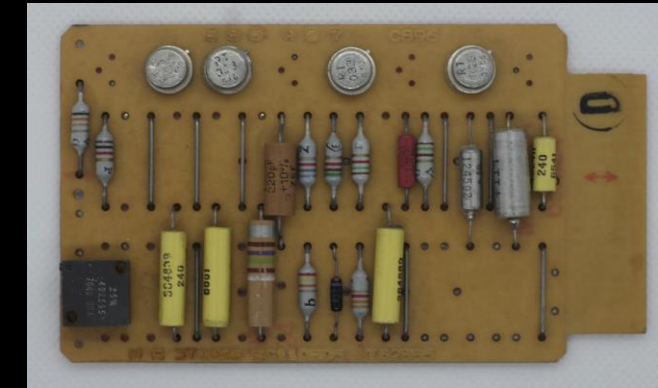
Last week CDC had a press conference during which they officially announced their 6600 system. I understand that in the laboratory developing this system there are only 34 people, “including the janitor.” Of these, 14 are engineers and 4 are programmers, and only one has a Ph. D., a relatively junior programmer. To the outsider, the laboratory appeared to be cost conscious, hard working and highly motivated.

Contrasting this modest effort with our own vast development activities, I fail to understand why we have lost our industry leadership position by letting someone else offer the world’s most powerful computer. At Jenny Lake, I think top priority should be given to a discussion as to what we are doing wrong and how we should go about changing it immediately.

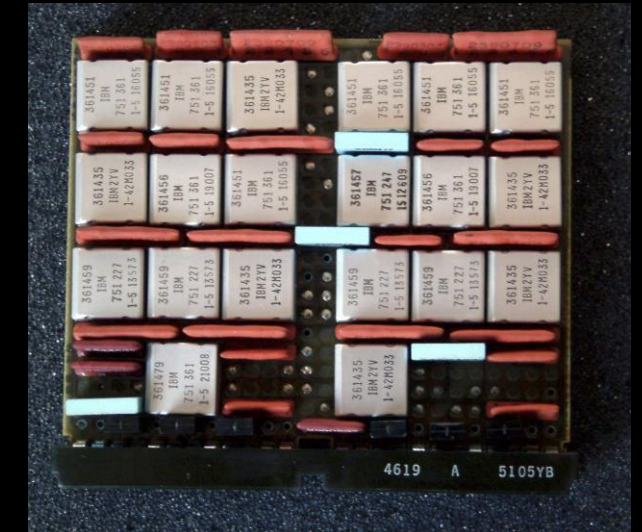
- T.J. Watson, Jr.

# Key Technology Innovations

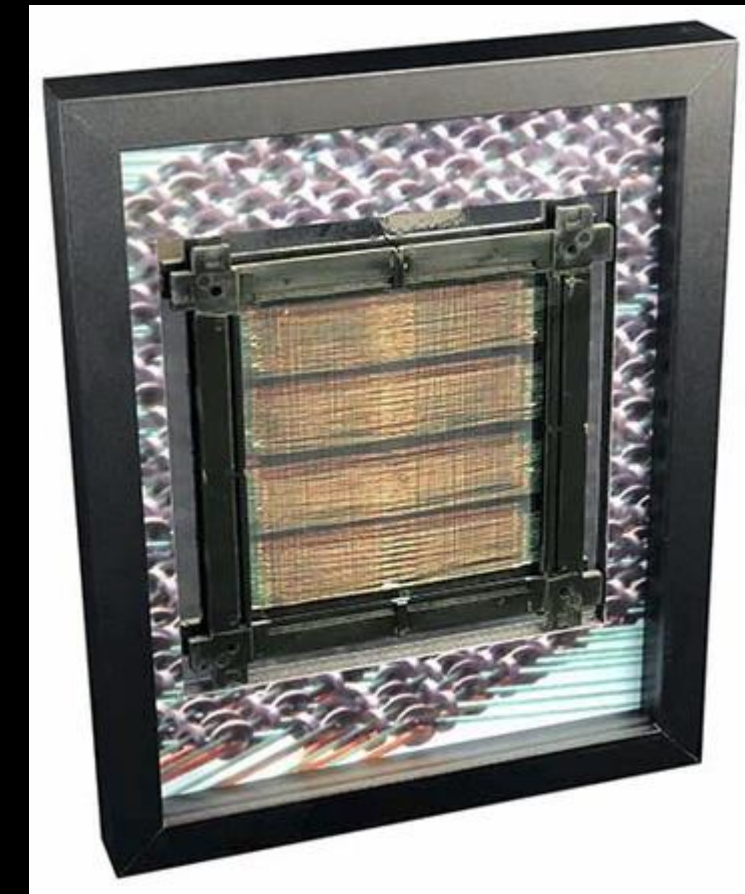
- IBM moved from its Standard Modular System (SMS) circuit technology to Solid Logic Technology (SLT)
- Substantial improvements made to main-memory magnetic core storage.
- SCAMP's 'read only control storage' technology allows microcoding of the architecture in emulation of other architectures (like the 1401)
  - Do not confuse SCAMP with the same-named IBM 5100 (world's first personal computer)



SMS



SLT

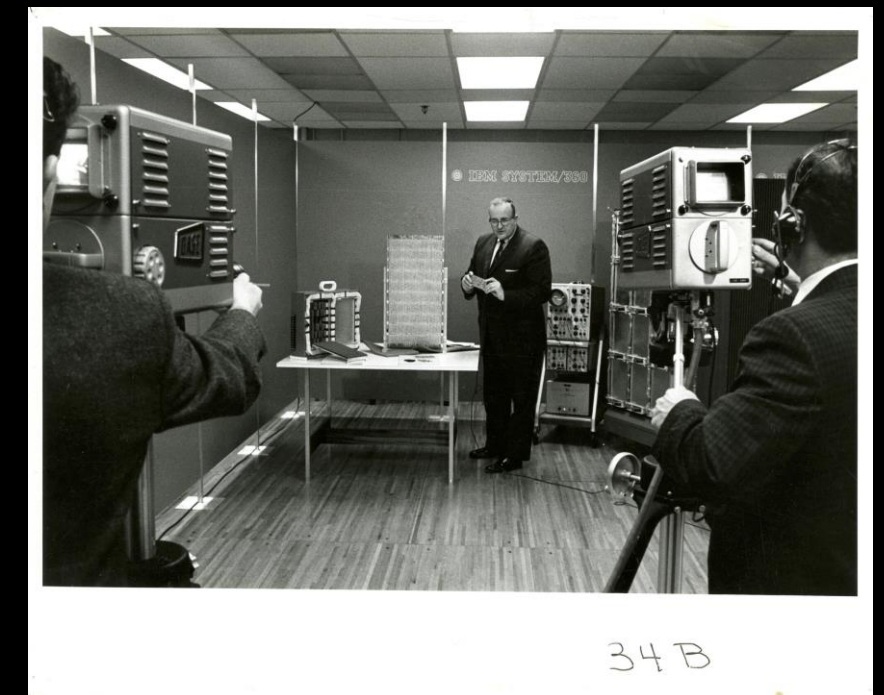


System/360 Core Memory on Sale on eBay



# 7 April, 1964: Announcement Day!

- IBM has to make its biggest announcement as soon as it can.
- Tom Watson, Jr. makes the announcement (“... the most important product announcement in company history”) from Poughkeepsie Building 005
  - 200 reporters boarded a special train in Grand Central Terminal that took them to the announcement
  - Live feed to 63 US cities and 14 countries



# 7 April, 1964: Announcement Day...

- **A massive success, yet:**

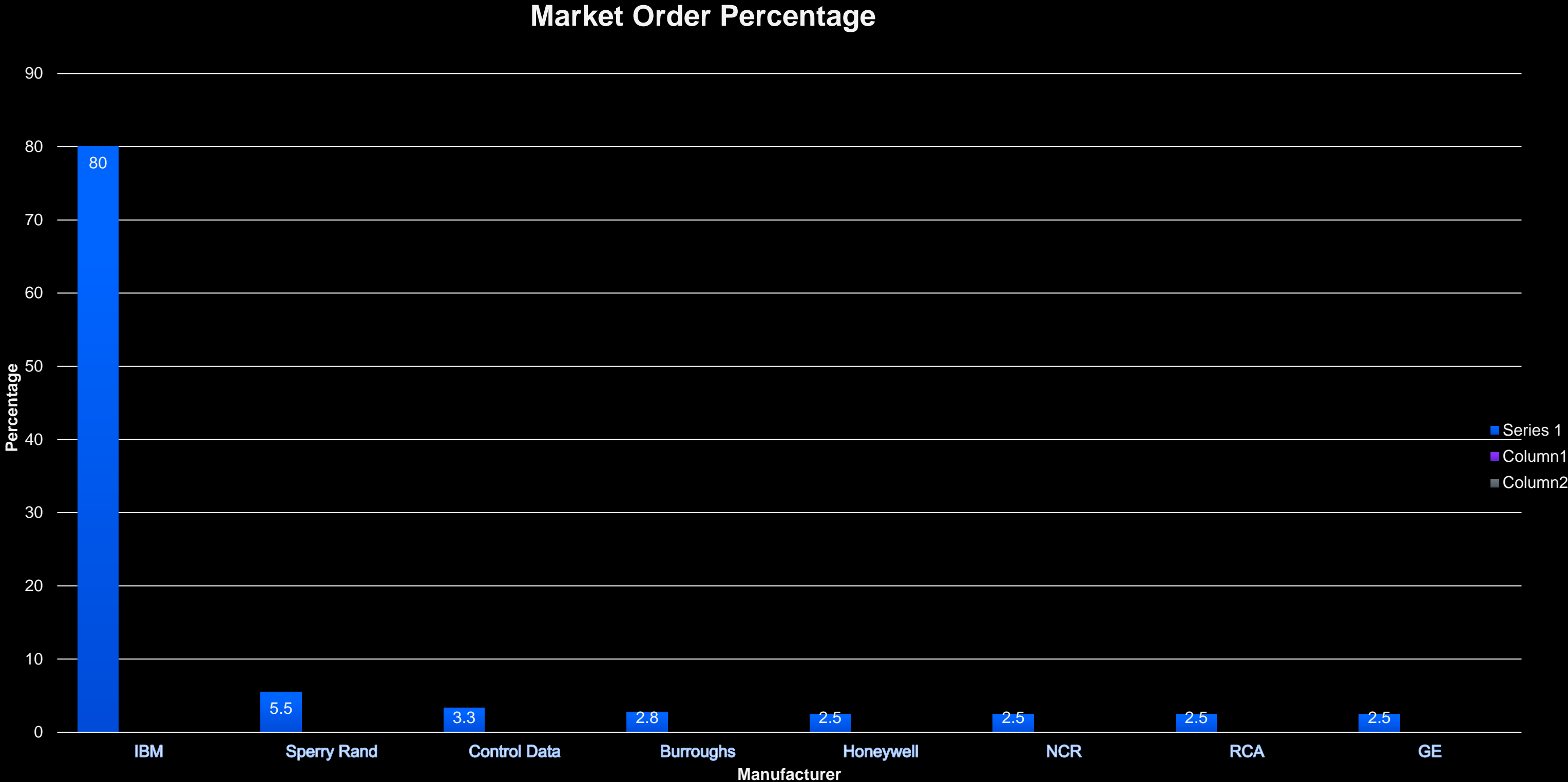
- “But when I looked at those new products, I didn’t feel as confident as I had liked. Not all of the equipment on display was real; some units were just mock-ups made of wood. We explained this to our guests, so there was no deception, But it was a dangerous cutting of corners - not the way I think business ought to be done and an uncomfortable reminder of how far we had to go before we could call the program a success”

- Tom Watson, Jr., *Father Son and Company*, page 351.





# Reactions: Market Share - Installed and On-order 1964-1965



Source: *IBM's Use and Abuse of Power*

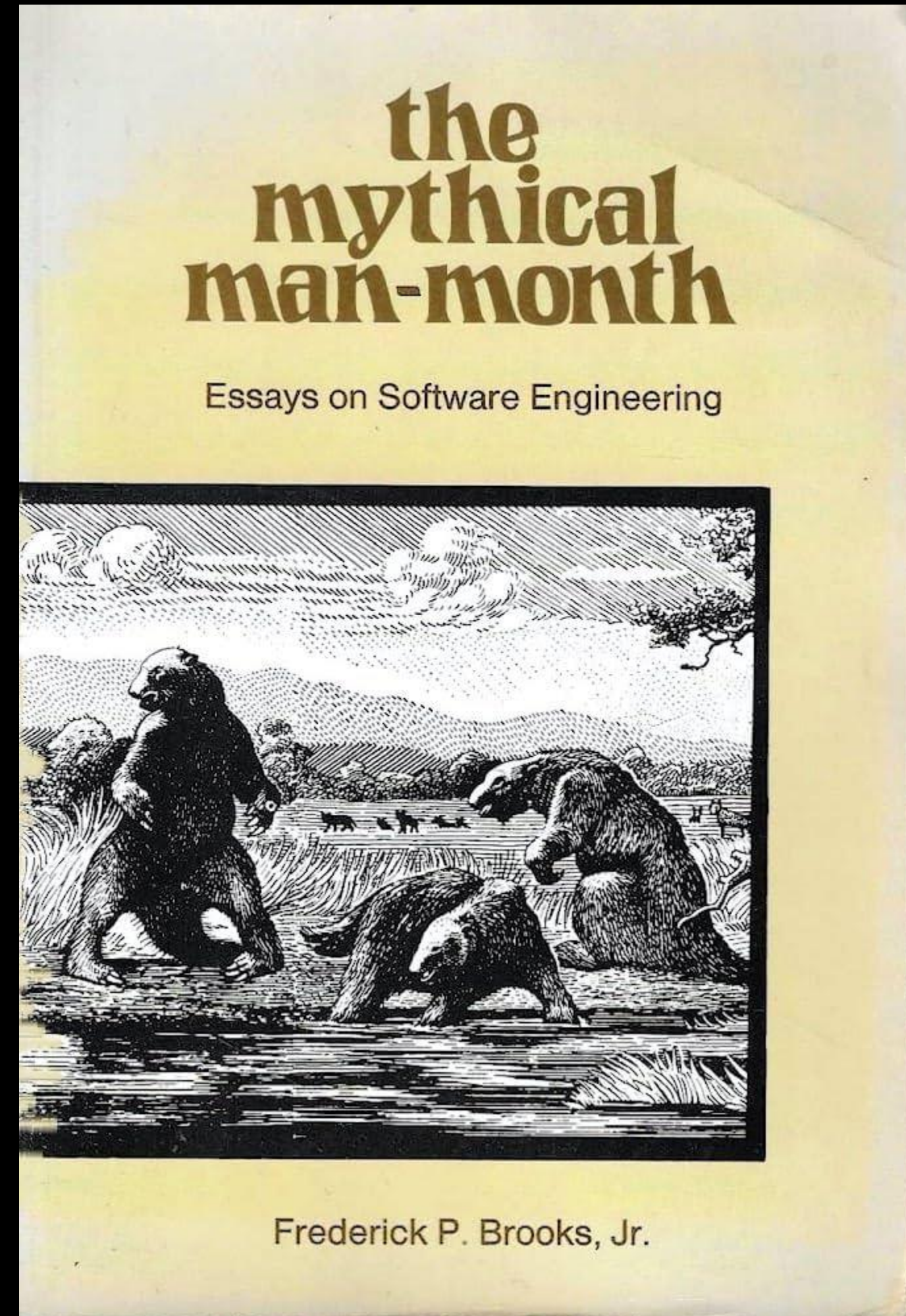
# Negative Reactions

- **No support for time sharing**
  - MIT abandons its relationship with IBM to work with GE and its time sharing system MULTICS
  - IBM works on TSS and the Cambridge lab works on what was to become VM and CMS.
- **No support for virtual storage (“dynamic address translation”)**
  - Came later with the System/360 Model 67 and System/370
- ***U.S. v. IBM* was filed in U.S. District Court, Southern District of New York on January 17, 1969**
  - Alleged that IBM had monopolized or attempted to monopolize the business general purpose electronic digital computer system market
- **The Hubris of Success**
  - Exclusion of industry standards
  - Next generation of future systems



# The Challenge of Software Development

- **Software development was a emerging technology; IBM's experience:**
  - 10K lines of code (LOC) for the 650, 100K LOC for the 1401
  - S/360 was estimated to 1M LOC initially, grew to 10M LOC; Original estimate \$40M, then \$125M, final cost \$500M (\$4.8B in 2024)
  - Multiple operating systems had to be created for specific machines/memory sizes.
- **Fred Brook's documents the lessons learned in "*The Mythical Man-Month, Essays on Software Engineering*"**



# April 7<sup>th</sup> 1964 Announcement and Deliveries

<b>Model</b>	<b>Delivery</b>	<b>Memory</b>	<b>First Customer</b>
30	Jun 65	16K-64K	McDonnell Aircraft
40	Apr 65	32K-256K	Globe Exploration
50	Aug 65	128K-512K	Bank of America
60	-----	-----	-----
65 (was 62)	Nov 65	256K-1024K	Lincoln Lab
75 (was 70)	Jan 66	256K-1024K	NASA



# Interesting System/360 Use Cases

# Apollo Moon Mission

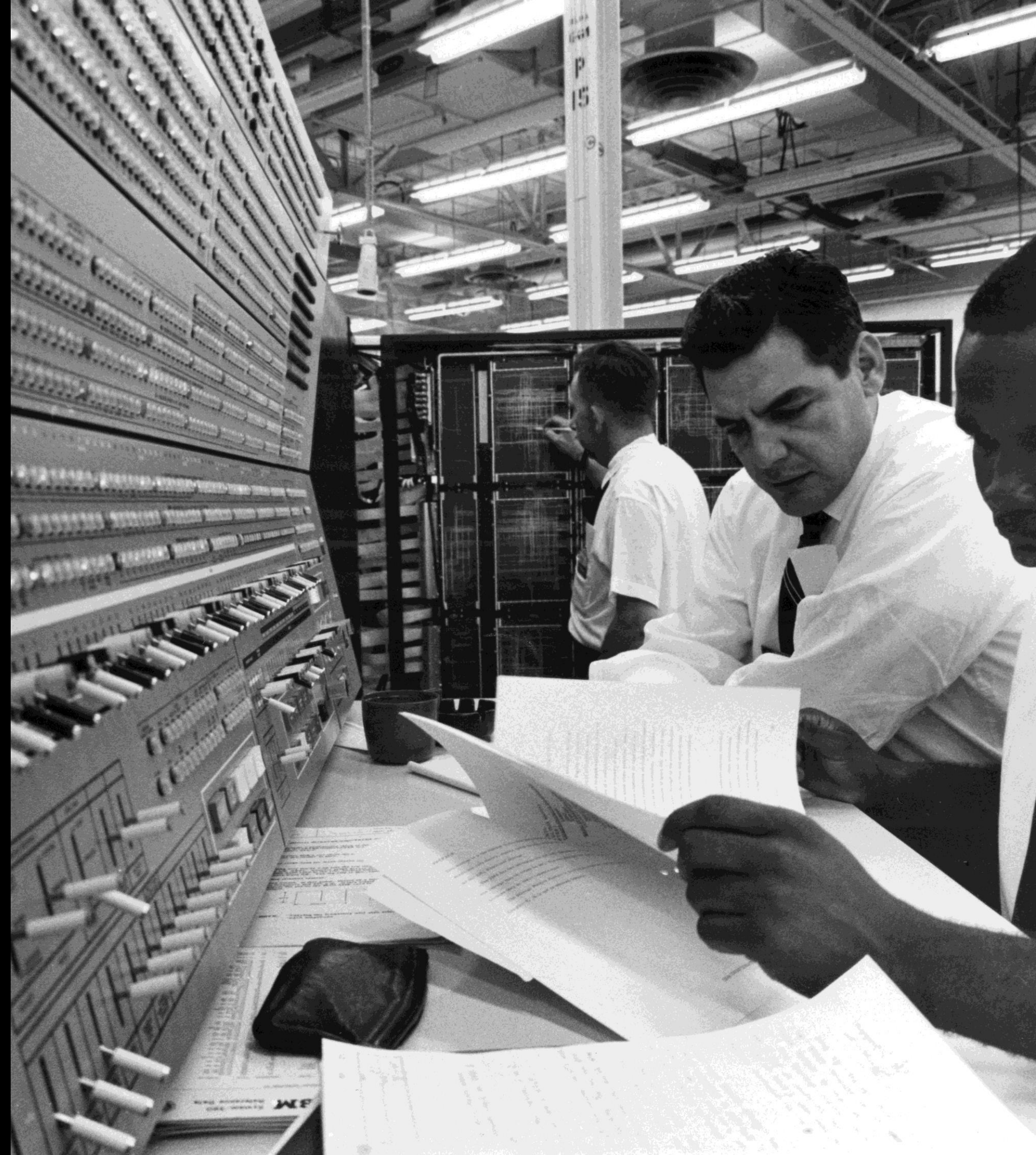
- Transitioned from five IBM 7094s to five IBM System/360 Model 75Js which were responsible for:
  - Launch systems
  - Management of telemetry data
  - Orbit computation and trajectory determination
  - Mission planning
  - Reentry
- NASA contractors Rockwell and Caterpillar work with IBM to create what is now called IMS to help track the millions of parts needed for the Apollo rockets and spacecraft
- The Apollo Real-Time Operating System (RTOS), a modified version of OS/360 becomes the single operating system to support all Apollo activities





# IBM System/360 Model 75J

- **First non-microcoded System/360**
- **Configured with 1M core storage with 750 nanosecond access time**
- **Supported four-way interleaved storage**
- **Purchase price: \$2.5M-\$3.5M (\$25M-\$35M in 2024 dollars)**





# RTOS Extensions to OS/360

- Creation of a new task dispatcher and the concept of tasks which are independent of their creator, run with their own PSW key, and wait for work, which can be queued
- Support for a synchronized high resolution (10 micro second) clock and interval timer
- Real-time I/O control system for devices supporting a device-independent display format language
- Support for IBM 2361 Large Core Storage (4M of additional storage)
- Fast swap-over (10 seconds) to backup
- Houston Automatic Spooling Priority (HASP) system to control job input and output





# The Iconic Apollo Control Room

- The display consoles in the Apollo Control room were connected back to the IBM System/360 Model 75 through a 2701 control unit





- **FAA Air Traffic Control (ATC)**
- **IBM adapted the System/360 Model 50 and System/360 Model 65 to serve as processors (9020) for the FAA's 20 en route Air Route Traffic Control Centers (ARTCCs)**
  - A maximum configuration was 12 9020s
- **Also installed in London, UK**
- **Each system could handle 325-650 flight plans**





# Thirty Years Later

# Stuart Alsop's Prediction

**In March, 1991, venture capitalist Stuart Alsop II stated:**

- "I predict that the last mainframe will be unplugged on March 15, 1996".

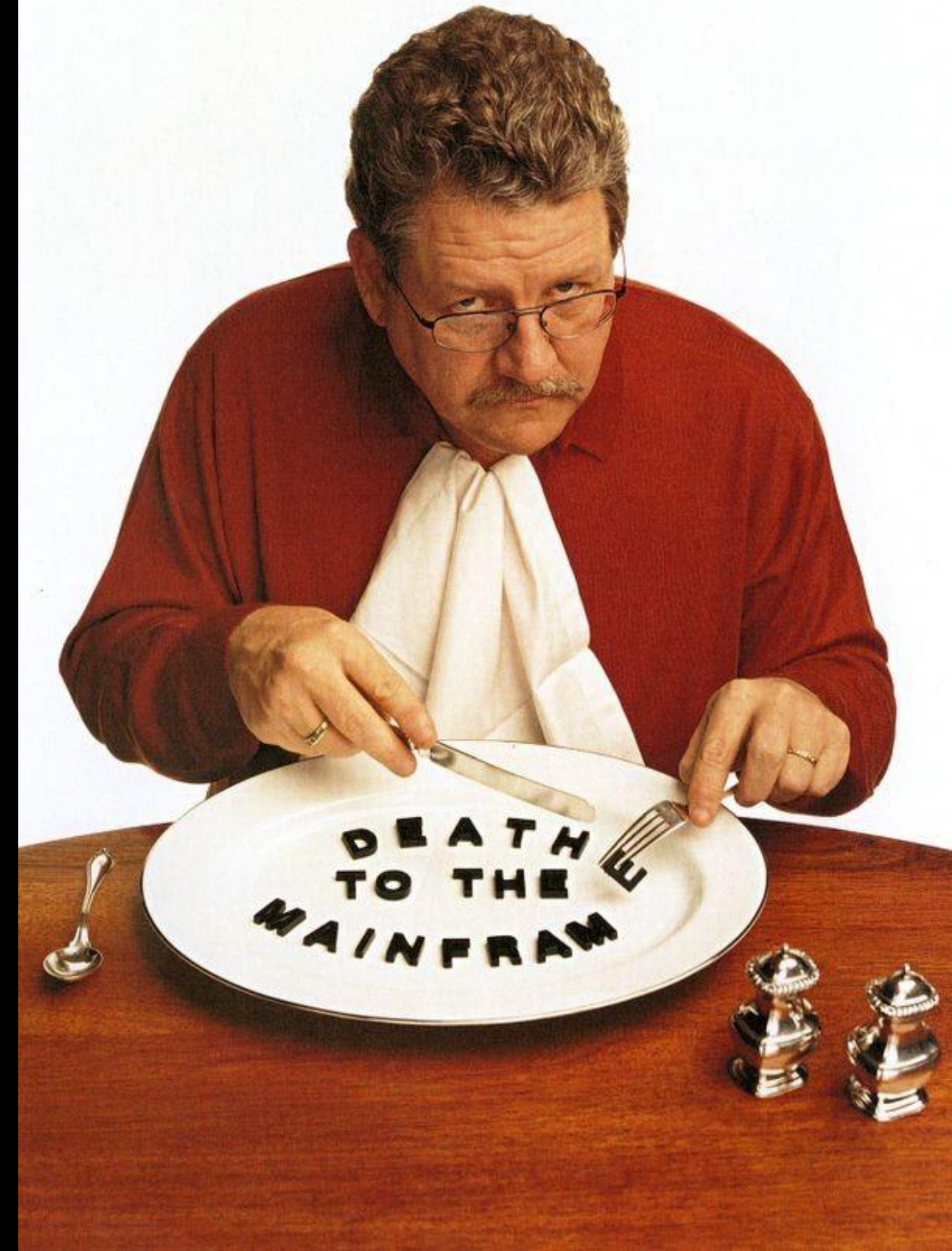




# Stuart Alsop's Prediction

In March, 1991, venture capitalist Stuart Alsop II stated:

- "I predict that the last mainframe will be unplugged on March 15, 1996".
- He changed his mind in 2002



# Sixty Years Later



# The Modern Mainframe

## Have you ever:

- Withdrawn cash from a ATM?
- Checked your bank balances in an app?
- Made a purchase at a major retail store?
- Purchased an airline ticket?
- Booked a hotel room?
- Had UPS or FedEx deliver a package to your house?

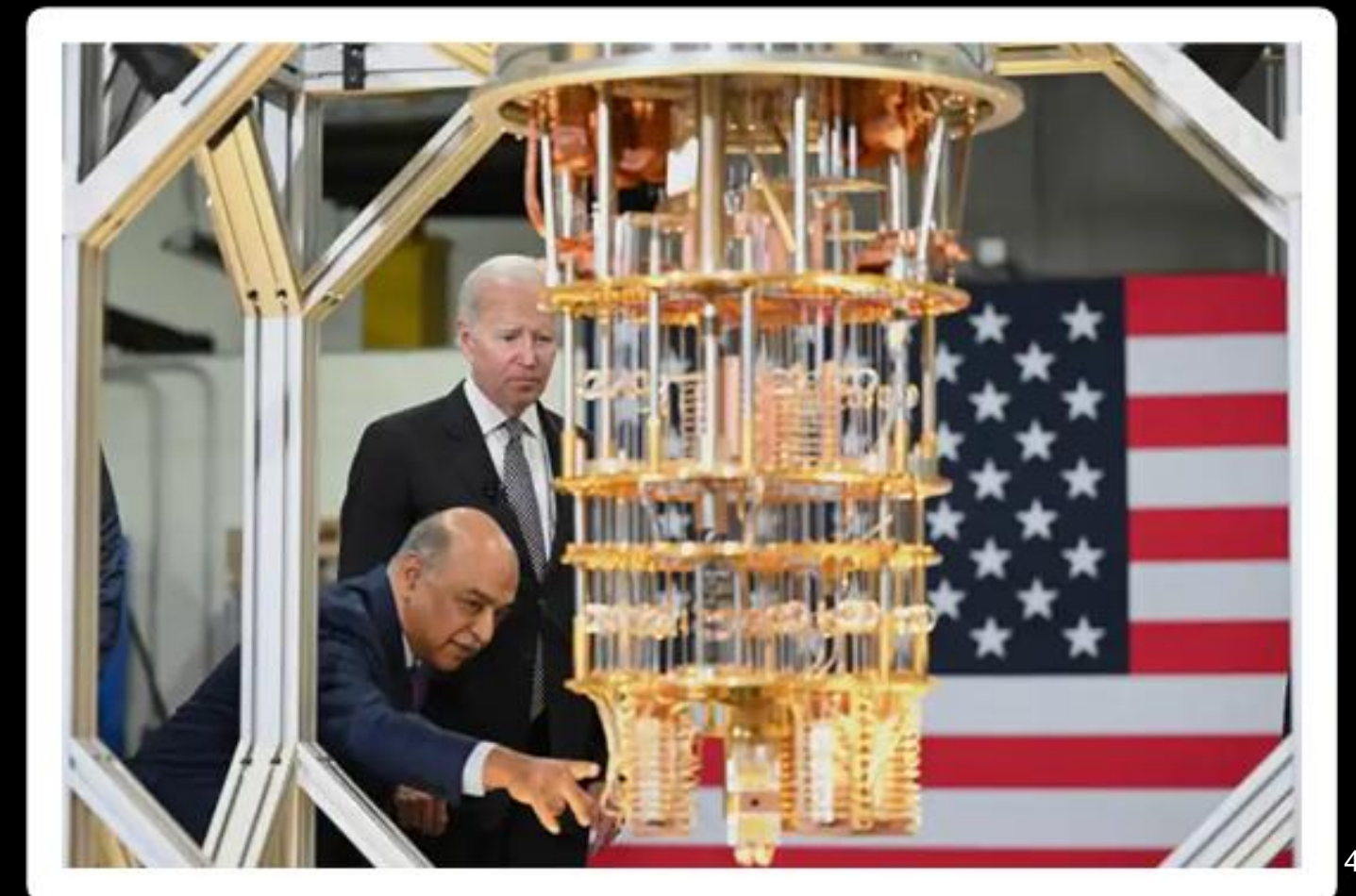


Then you have utilized the **WORLD'S GREATEST COMPUTING PLATFORM** and never knew it!

These transactions utilized an **IBM Z** or **LinuxONE** server

# Just a Few of the Innovations over the Past 60 Years

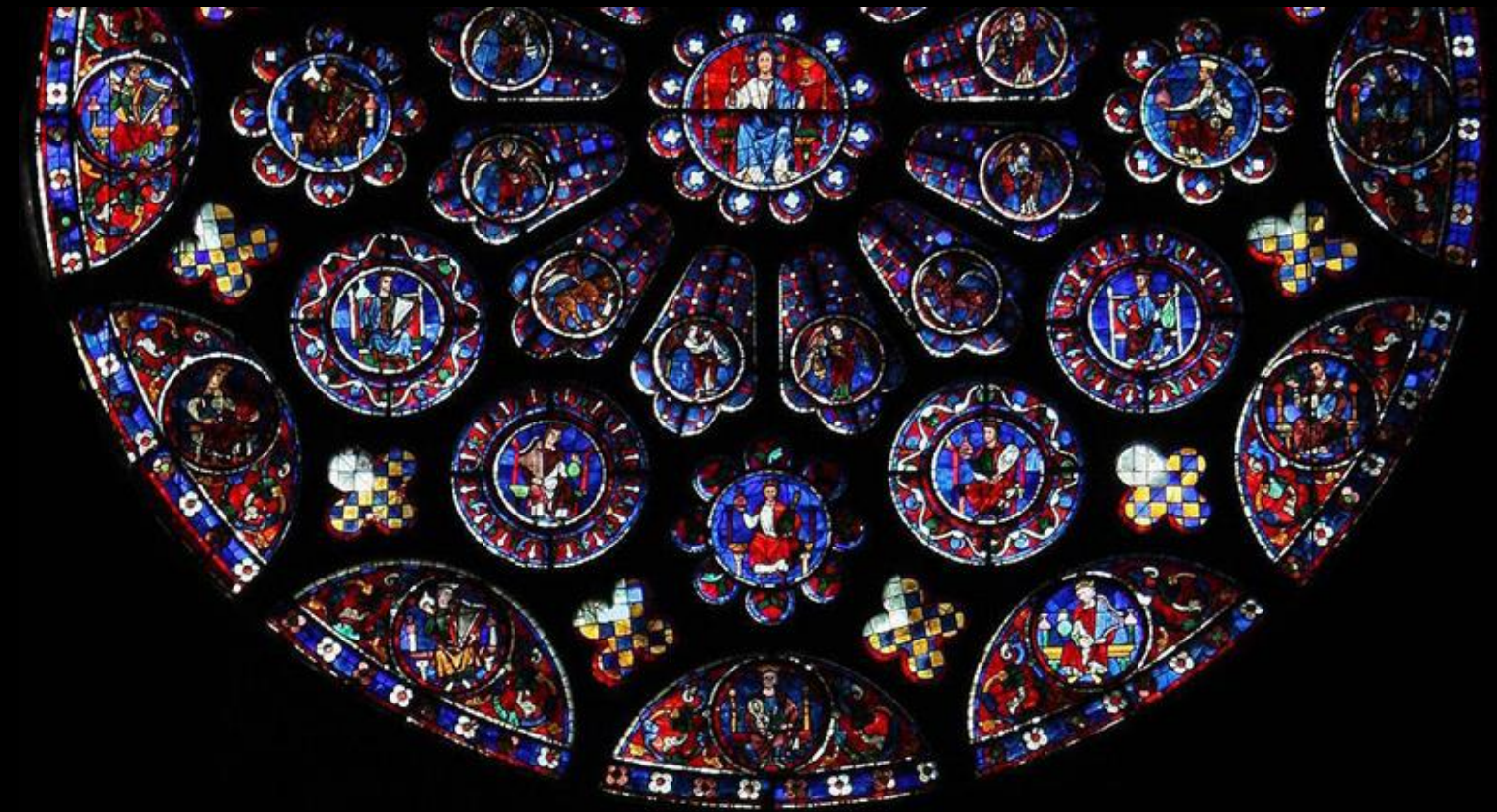
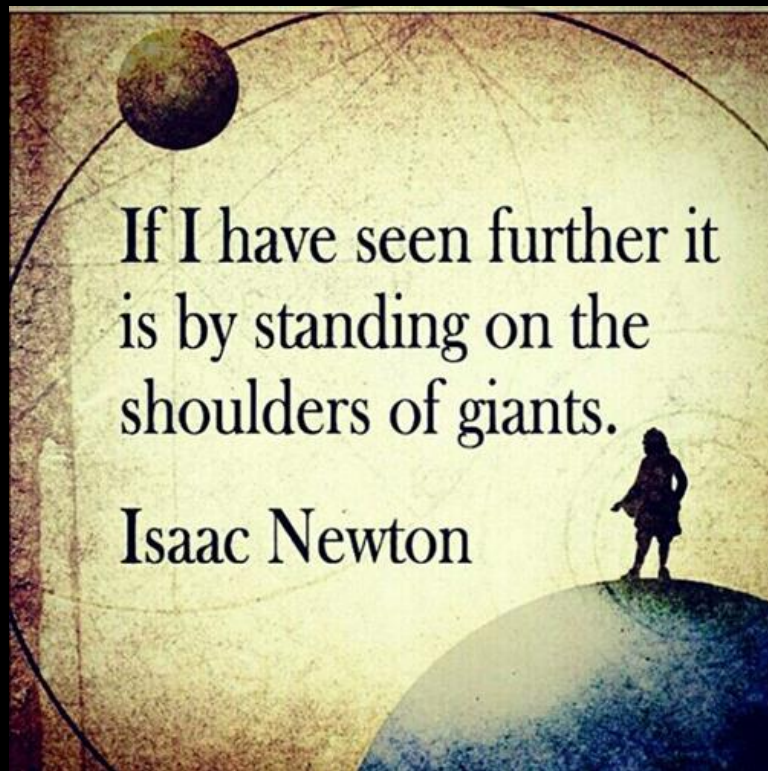
- Time Sharing
- Transaction managers (IMS<sup>®</sup>, CICS<sup>®</sup>)
- Database managers (Db2<sup>®</sup>)
- Operating Systems (z/OS<sup>®</sup>, z/VSE<sup>®</sup>, z/TPF, Linux), Hypervisors (z/VM<sup>®</sup>, KVM, PR/SM)
- Communications (SNA, TCP/IP, Firewall, IDS)
- Cryptography and Security Management
- z/OS UNIX System Services
- Parallel Sysplex<sup>®</sup>
- Web serving/hosting
- Containers
- Quantum Computing
- Quantum Safe Computing
- ... and oh so much more





# Where we Stand

**Nanos gigantum humeris insidentes**



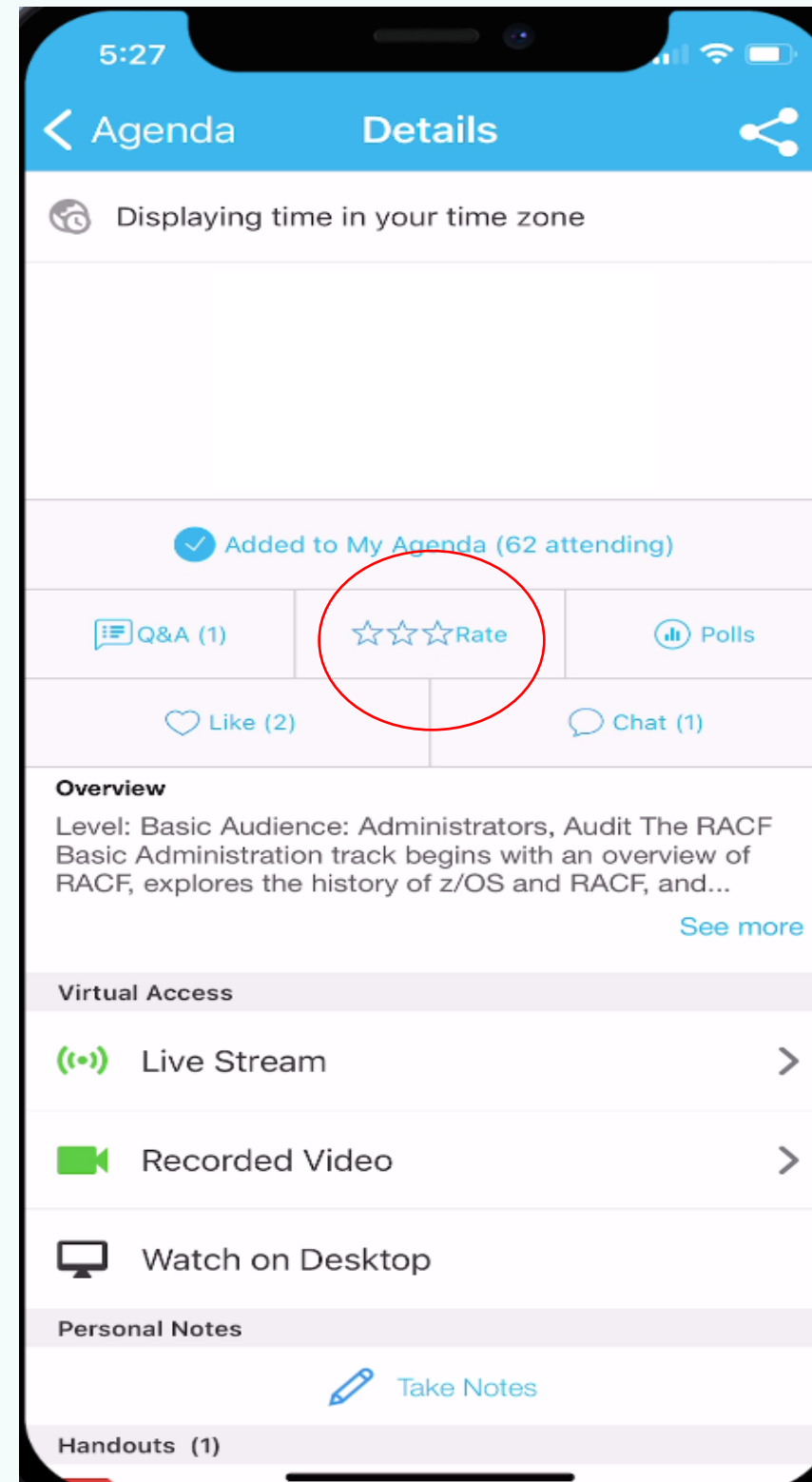


## Session Evaluation

Be sure to rate your experience using the VSC2024 app.

Your opinion helps us bring you the best experience.

Please let us know your thoughts.





# The IBM System/360

The 'Bet your Business' Gamble that  
Transformed the Information Technology Industry

Mark Nelson, CISSP®, CSSLP®  
Senior Technical Staff Member  
z/OS® Security Server (RACF®) Design and Development  
IBM® Poughkeepsie  
[markan@us.ibm.com](mailto:markan@us.ibm.com)

VSC-2024



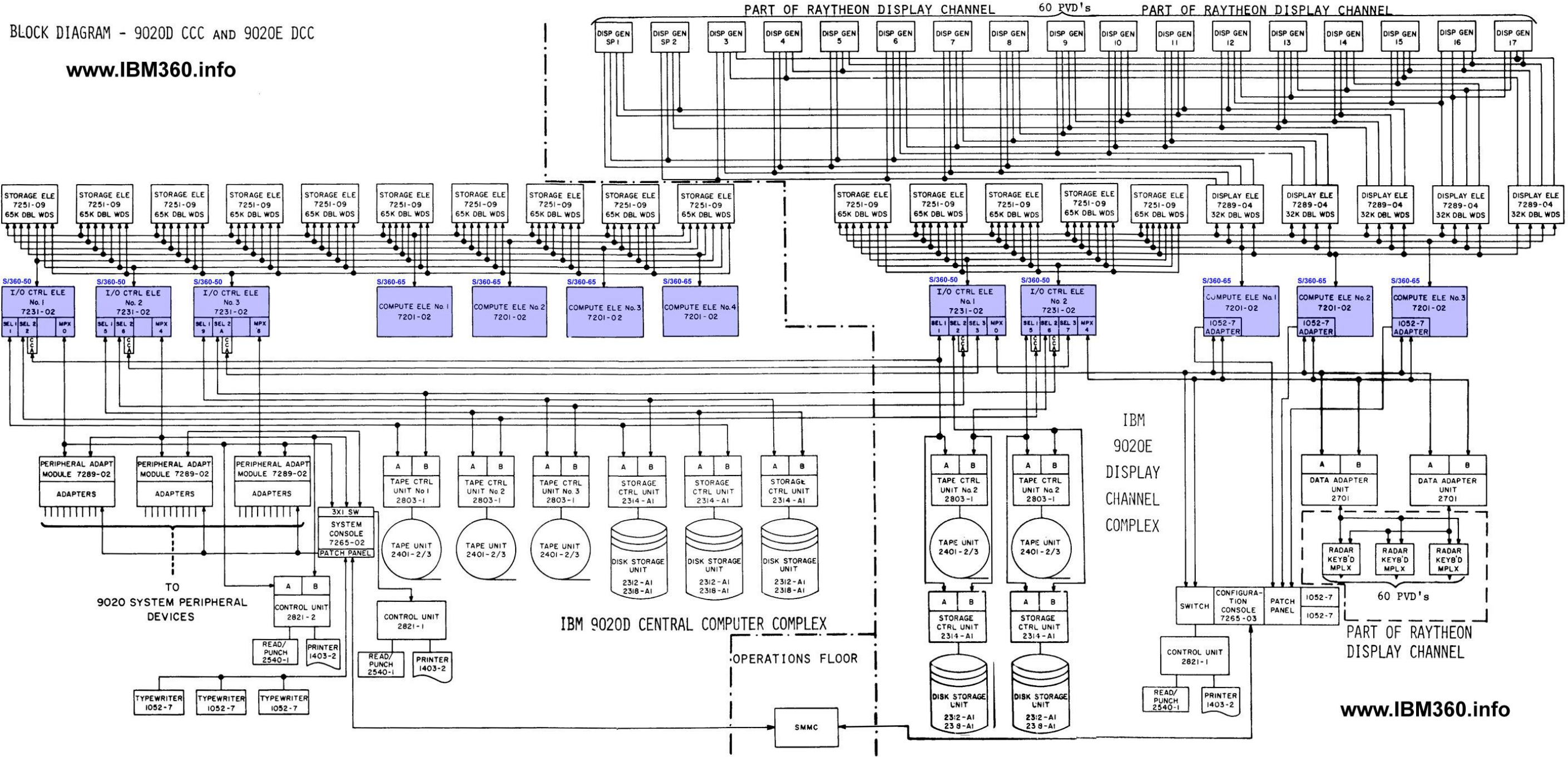
# Additional Information



# FAA ATC System/360

BLOCK DIAGRAM - 9020D CCC AND 9020E DCC

[www.IBM360.info](http://www.IBM360.info)



[www.IBM360.info](http://www.IBM360.info)



# Project Vanguard Computer Center

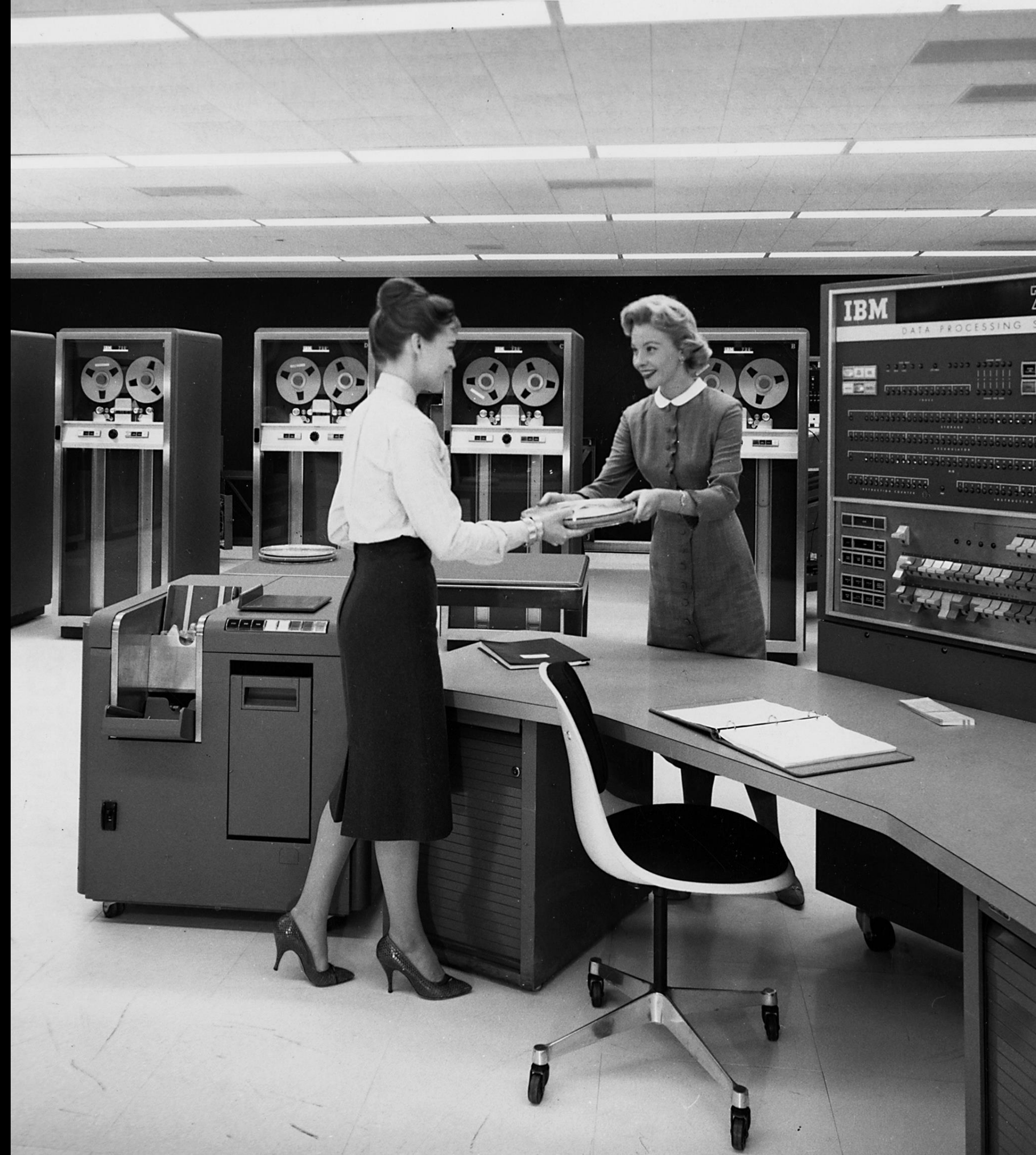
- Established June 1957, Washington D.C. with a backup in building 701 in Poughkeepsie N.Y.
- Consisted of an IBM 709 in each location
- Supported orbital calculations and tracking data for satellites





# IBM 709 Data Processing System

- Vacuum tube technology
- 180 instructions
- Improved version of the IBM 704
- Introduction of the “data-synchronizer units” (we’d call them channels today)
- 32,768 words of 36-bit word magnetic core memory
- Could execute 42,000 addition or subtraction instructions per second
- Could multiply two 36-bit integers at a rate of 5000 per second
- An optional hardware emulator executed 704 programs





# Real Time Computer Center (RTCC): Project Mercury

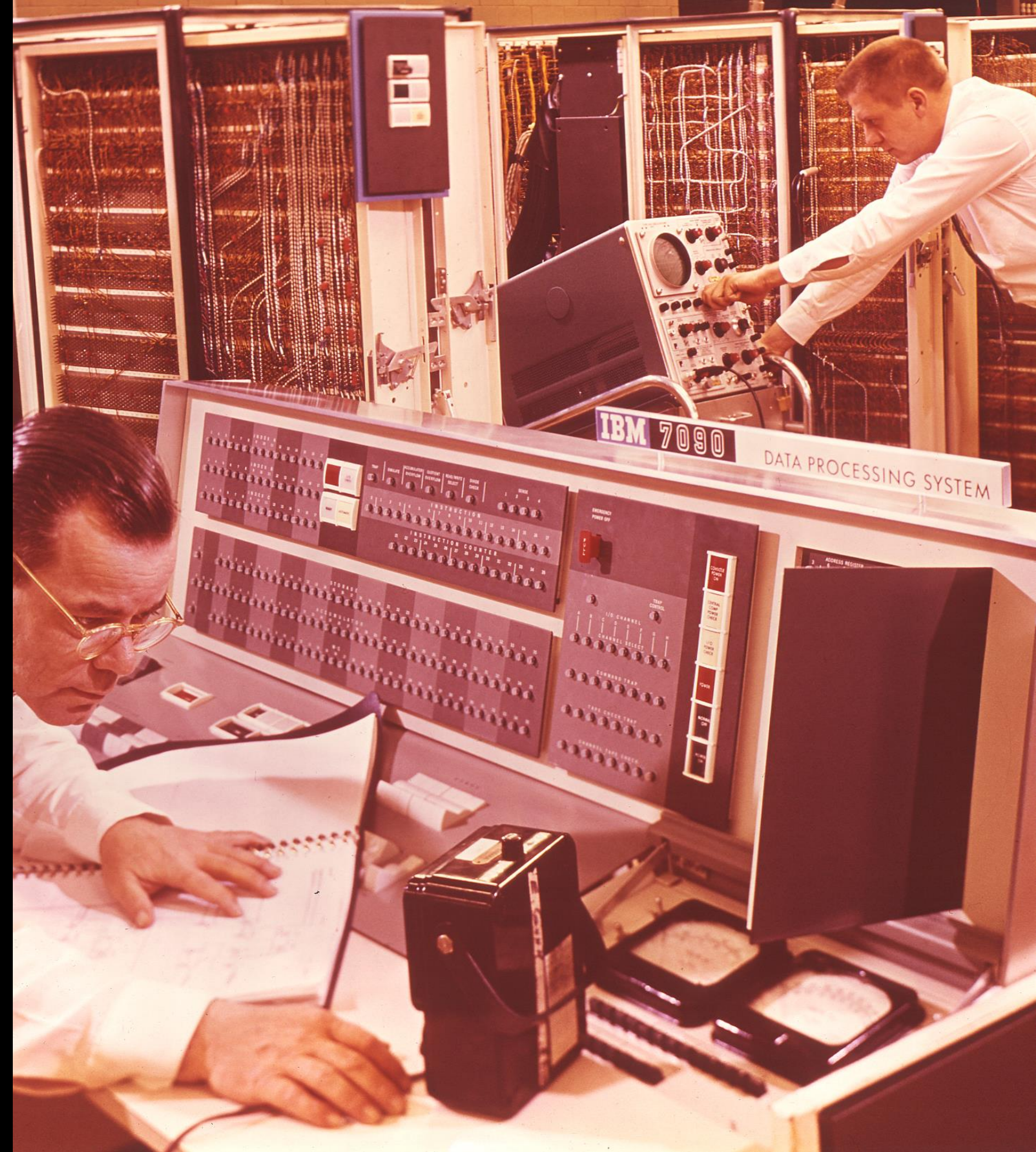
- Established in 1960 at Goddard Space Flight Center in Greenbelt, M.D.
- Three IBM 7090s
- Consolidated information from tracking sites and launch control in Cape Canaveral to provide a real-time continually updated aircraft status
- Special-purpose control program/monitor with limited multiprogramming capabilities





# IBM 7090 Data Processing System

- **Transistorized version of the IBM 709**
  - Six times faster
  - Far more reliable
  - Half the cost
    - but still \$63K a month in 1960 dollars (\$660K in 2024 dollars)
- **32,768 words of 36-bit magnetic core memory (same as 709)**





# RTCC: Project Gemini

- **Had to control two spacecraft at the same time**
- **Five IBM 7094s, partitionable into:**
  - Two mission systems, one b/u
  - One mission, one test/training, one b/u
- **Still has a custom control program/monitor, but commercial off-the-shelf operating system (IBSYS) begins to be used**





# IBM 7094 Data Processing System

- **Instruction set increased to 274 instructions**
- **A basic machine operating cycle of 2 microseconds**
- **Double-precision floating-point operations**
- **7094 II**
  - Shorter cycle time
  - Less cycles for multiplications and divisions
  - Memory interleaving



# What Happened to the Mainframe?

- **The IBM Mainframe continues to evolve, bring more and more processing power and added reliability and security**
- **The evolution continued through the the IBM System/370, 303X, 308X, IBM 3090, System/390, zSeries (900, 800, 990, and 890), System z9, System z10, zEnterprise System (z196, zEC12, z13, z14, z15, z16)**
- **... and while an operational mainframe never made it to the moon, 37 IBMers were honored when their names were left on the moon during Apollo 15 in recognition of their Apollo efforts**

