TECHNICAL BRIEFING

Memorex Corporation
Santa Clara
April 3, 1975

AGENDA

I. Presentation	John Eastling	1:30 - 3:00
II. Illustrative Excursion	John Eastling Tom Gardner Roger Holen	3:00 - 4:15
III. Review, Questions, and Coffee		4:30

TECHNICAL BRIEFING PARTICIPANTS

John R. Eastling is a Vice-President of Memorex Corporation, presently responsible for Litigation Support. Mr. Eastling joined Memorex in 1967 as Managing Director of European Operation located in London. In 1970, he moved to Santa Clara where he became Vice-President of Systems, responsible for the development of the Memorex computer system products. His next assignment was in Corporate Planning, which continued until his current position.

From 1961 until 1967, Mr. Eastling worked at Control Data Corporation in a variety of marketing, financial, and planning positions. He holds a MBA (1961) and BA (1959) from Harvard University.

Thomas E. Gardner is Director of Disc Subsystem Development at Memorex. He joined Memorex in 1968 as a Senior Electrical Engineer and has held a series of technical and managerial positions within the Engineering operation. From 1971 - 1973, he managed the linear and digital circuit design groups for the 3670 Disc Drive. Prior to Memorex, Mr. Gardner was an electrical engineer working on advanced jet engine fuel controls for the Hamilton Standard Division of United Aircraft. Mr. Gardner has a BSEE from Brooklyn Polytechnic Institute (1962) and a MSEE in automatic control systems from Rensselaer Polytechnic Institute.

Roger W. Holen is Manager of Litigation Systems for Memorex. Mr. Holen joined Memorex in 1970 as a programming supervisor in the Memorex computer systems development organization. In 1972, he joined the Education Staff with responsibility for technical training of Systems Engineers and Sales personnel. Mr. Holen assumed his current position in 1 974, and provides system design guidance for litigation support activities.

Mr. Holen's previous experience since 1960 is in the computer programming field with B. F. Goodrich and Household Finance Corporation. He attended the University of Minnesota.

PRESENTATION OUTLINE

I. MEDIA

Machine-readable media for information storage and data interchange.

- **Punched Card**
- **Magnetic Tape**
- **Disc Pack**

II. DATA STORAGE

Data processing is the processing of stored data.

- **Data Management**
- **Storage Hierarchy**
- **Storage Level Characteristics**
- **Random vs. Sequential Storage**

III. DATA COMMUNICATIONS

Put data where the user needs it.

- **Terminals**
- **Transmissions**
- **Telecommunications Control**
- **Network Processing**
- **Network Elements**

IV. ILLUSTRATION

Working environment display of computer products.

- **Disc Drive**
- **Disc Control**
- **Manufacturing Process**
- **Mixed Vendor Computer System**

V. DEMONSTRATION

Remote access to a large complex data base.

- **Terminal Network**
- **User Interaction**
- **System Control**
- **Data Base**
- **Example**

Defacto Industry Standards

There are three types of machine-readable media that are commonly used for data input or output and provide some data interchange among general purpose computer systems. (See display.)

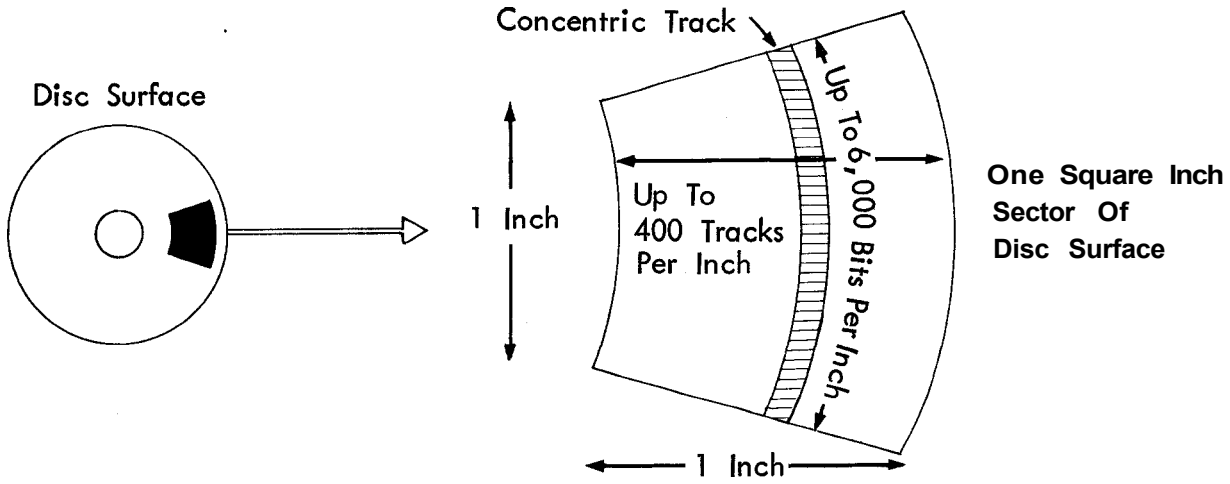
1. Punched Cards
   - 80 columns of data, one byte each (a 96 column version has been more recently introduced and is less prevalent).
   - input at 500 - 1000 cards per minute in typical systems, a data rate of about 1. 5 kilobytes per second.
   - convenient for data entry and unit record filing, no longer widely used for data storage per se.
2. Magnetic Tape
   - 1/2 inch by 2400 feet per reel.
   - 200 bpi (1960) to 6, 250 bpi (1974)
   - 37 1/2 to 200 inches per second
   - capacity per reel approximately 1 00 million bytes maximum
   - transfer rate, up to 1. 25 million bytes per second
   - time to pass tape end-to-end, minimum 2 minutes
3. Disc Pack
   - 1 to 20 surfaces
   - 50 to 800 tracks per surface
   - up to 6, 000 bits per inch along track
   - capacity per pack, 200 million bytes maximum
   - transfer rate, up to 1 million bytes per second
   - time to access a given track, average 30 millisecond (30 accesses per second)

Status

All of the above types of media are removable for off-line storage, for subsystem data entry or output, or for data interchange with another system which possesses media - compatible devices. All are manufactured and sold by a number of companies, most of whom do not also produce or market the related computer equipment.

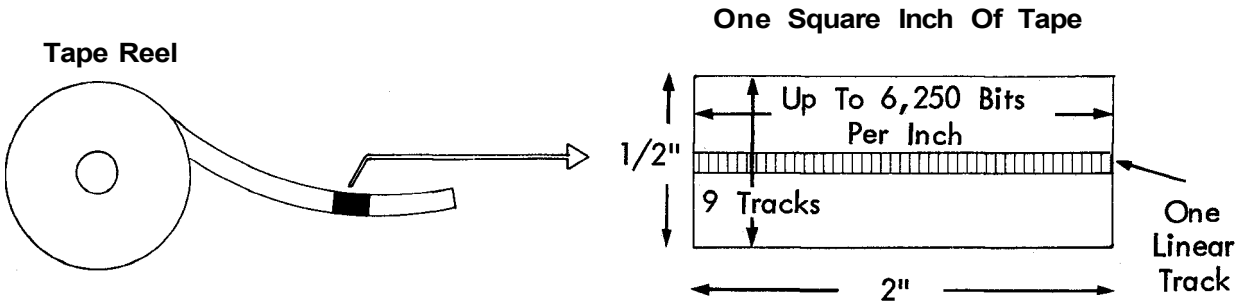
MEDIA COMPARISON

Disc



On a 200 million byte disc pack, one square inch of magnetic surface contains about 400 tracks x 4000 bits per inch = 1. 6 million bits or about 200, 000 bytes.

Tape



On a 6, 250 bpi tape, one square inch of magnetic surface contains 9 tracks x 6250 bits x 2 inches =. 11 million bits, or about 12, 500 bytes (plus check code).

II. DATA STORAGE

Almost as soon as the stored-program computer was developed, the need for additional data storage arose. Data processing "work" is essentially accomplished by the processing of data stored on-line in machine - readable form. The performance characteristics of the data storage device requirement are determined by the user application. The key characteristics of data storage are:

cost per byte
access time per record retrieved
byte capacity

A. Data Management

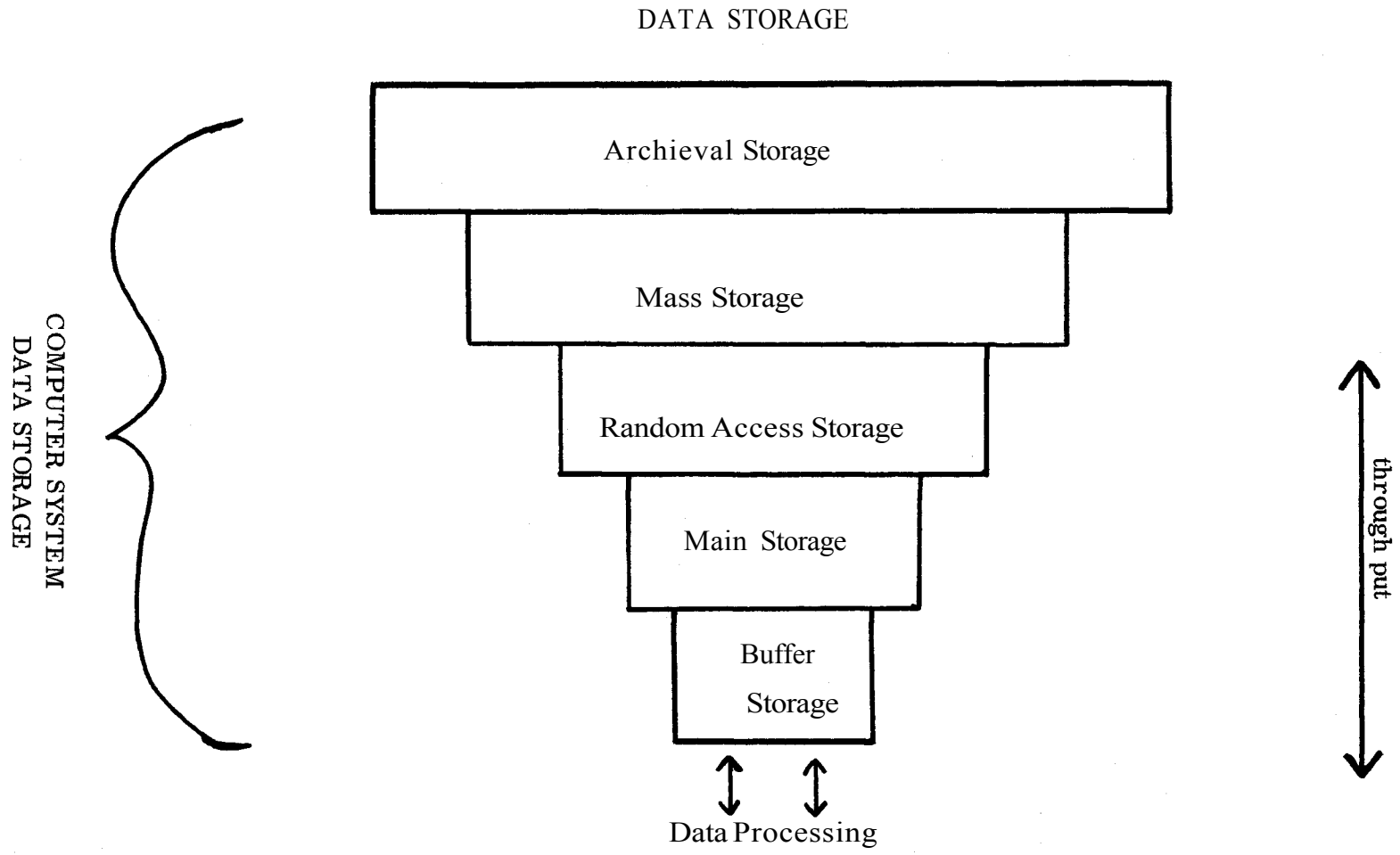
Data Management provides an orderly relationship between user programs and data files.

1. Security
   - . withhold access unless authorized
   - . protect data integrity during update
2. Separation
   - . separate user program from data files
   - . enable multiple users to share files
3. Structure
   - . common data base design
   - . distributed data base feasibility

B. Storage Hierarchy

The design of a storage hierarchy is the art of organizing data location and transfer among levels of storage.

1. Cost Optimization
   - . On-line, high speed data storage is expensive. The computer system can store more total data on-line for lower cost if some of that data is stored on higher capacity, lower cost devices until needed for processing.
2. Objective of Automated Storage Hierarchy
   - . The computer system sees the apparent capacity of a low-cost, large capacity device at approximately the speed of a high-cost small capacity device.



Procedure: Funnel data from storage level to storage level.

Infrequently used data ⟷ often used

Low cost data storage ⟷ high cost

Slow data retrieval ⟷ fast retrieval

Large capacity storage ⟷ small capacity

3. Method

. There is a high probability of repeated access to a given data set once it has been accessed.

4. Example

. Virtual Memory is one example of Storage Hierarchy design. The central processor accesses a larger Main Storage than actually exists. The "missing" Main Storage is stored on a Disc Drive. When an access to Main Storage defaults, the missing data record (and nearby records) are automatically brought into real Main Storage from Disc. This block of data replaces the least used block already in Main Storage.

C. Levels of Storage/Applications

The configuration designer attempts to match the application need to appropriate storage devices to obtain a cost-effective system.

1. Main Storage

. During a rocket launching, a computer monitors the rocket engine lift before firing the explosive bolts which hold the vehicle to the launch pad.

no time for auxiliary storage

2. Disc Storage (Primary Storage)

. An on-line credit bureau stores information on 35 million people for purposes of retail credit reference. Any subscribing store can interrogate the data base for a credit report on an individual. Each individual's record is 100 bytes.

response time requires Disc Drive storage, Main Storage costs would be prohibitive for 3.5 billion bytes (that's 35 Disc Drives of 100 million byte capacity).

3. Tape Storage (Archival/Sequential Storage)

. A large network of hospitals share a statistical record record computer system. In scheduled weekly runs,

DISC DRIVE DATA STORAGE

- Random Access → System Response
- Large Capacity → On-Line Systems
- Removable → Data Availability
- Non-Contact Recording → Reliability
- Multiple Units/System → Mass Production, Low Cost
- Magnetic Technology → Quantum Jumps in Performance

Precursor to . . . . . data management systems
to . . . . . on-line, remote access systems
to . . . . . expanded commercial data processing applications

Predominant Peripheral Equipment

- percent of on-line data storage
- percent of units, system value

the master file record of treatments for one million people is updated and aggregate statistical reports prepared.

sequential processing application, uses tape drives as the storage device for (again) 3.5 billion bytes, or 3500 bytes per individual.

D. Random Access Storage Devices

The Disc Drive has emerged as the most widely used auxiliary storage device in terms of:

total data stored on-line

peripheral portion of computer room equipment value

Among the reasons for the Disc Drives central role in data storage are:

The need for speedy access to large amounts of data.

The multiple (random) use of a single data base by application programs.

The trend towards on-line computer systems.

III. DATA COMMUNICATIONS

The availability of random-access storage devices in the 1960's enabled the implementation of "on-line computer systems". These are systems which incorporate communications capability to remote devices and their users outside the computer room.

A. Objective

Put data where the user needs it.

B. Status

From a relatively minor position in computing systems design and usage in the 1960's, Data Communication has grown rapidly in importance and emerges as a key element in future industry growth.

C. Implementation

1. Terminals
2. Transmission
3. Telecommunications Control

4. Network Processing
5. Network Elements

D. Network Systems

. Examples - Reservation Systems, Manufacturing Control Systems, Point of Sale Systems, etc.

. Provides useful information when and where needed.

ILLUSTRATION

Working environment display of computer products.

Disc Drive

Disc Control Unit

Manufacturing Process

Mixed Vendor Computer System

DEMONSTRATION

Remote access to a large complex data base.

Terminal Network

User Interaction

System Control

Data Base

Retrieval Example

Data Storage

I Data Processing Is The Processing of Stored Data

- Machine Readable Form
- On-Line Storage

II Data Management Provides Orderly Relationships Between User Programs And Data Files

- Security
- Separation

III Storage Hierarchy Design Is The Art of Organizing Data Location And Transfer Among Levels of Storage

- Data Access Is Expensive
- Objective: The System Sees The Apparent Capacity of a Low-Cost Large Storage Device at Approximately The Speed of a High-Cost Small Capacity Device
- Method: Based Upon The High Probability of a Repeated Access to a Given Data Set Previously Accessed

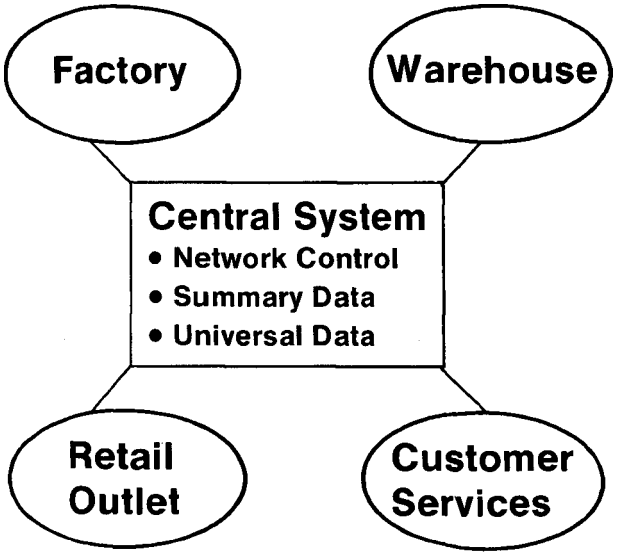
IV Levels of Storage

- Cost Per Byte
- Access Time Per Byte
- Byte Capacity

V Random Vs. Sequential Access

- The World Is Round And Random
- Disc Drives Are Standard Random Access Devices for Data Storage

Data Communication



Network Elements

- At User Locations
- Include: Subordinate Computer Systems
  Intelligent Terminals
  Simple Terminals
  Telephones
- Distributed Data Entry, Storage, Exchange, and Use

I Objective: Put data where the user needs it

II Status: From a relatively minor position in computing systems design and usage in the 1960's, Data Communication has grown rapidly in importance and emerges as a key element in future industry growth

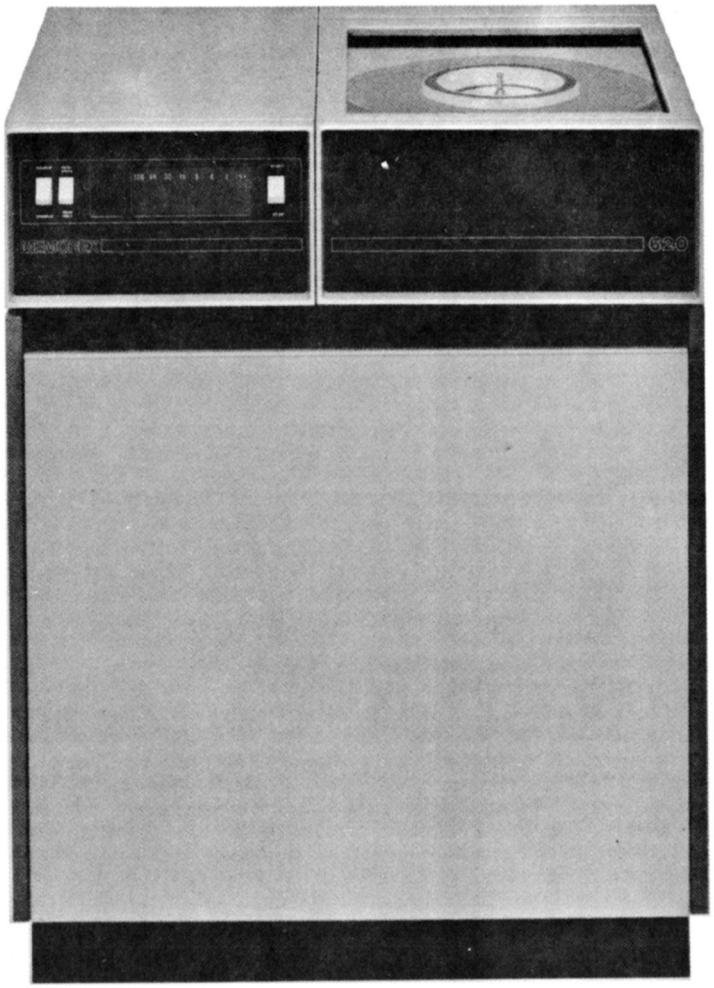
III Implementation:

- Terminals—Custom designed for specific user applications
  —Wide range of capability (telephones to small computers)
- Transmission—The cost of high speed data transmission is appreciably declining, satellite usage will enable further cost savings
- Telecommunications Control—The problems of codes, speeds, line types, security, queing, and priority are now being placed into programmable communications controllers
- User Networks—Will become routine in the next 5-10 years, building upon the foundation of existing networks for airlines, brokerage houses, credit services, etc.

IV Network Systems

5 pages omitted

Diagram of Memorex 370/155 Computer System
Diagram of Litigation Support Data Base Retrieval
3 pages on Demonstration Example of Litigation Support System

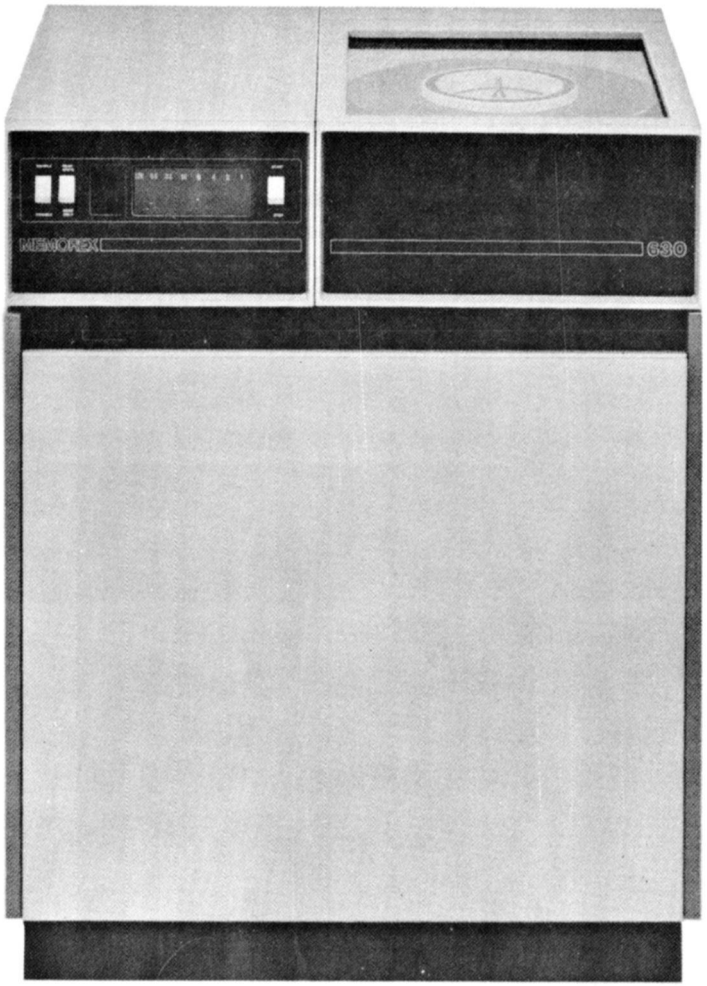


620
Disc Drive

IBM 2311 Model 11 Compatible
Connects to IBM System/360 Model 20,
or Memorex 50

- Spindle Rotation Rate . . . . . 2400 RPM
- Average Access Time . . . . . 50 Milli Seconds
- Pack Capacity . . . . . 5.4 Million Bytes
- Number of Tracks Per Surface . . . . . 200 Plus 3 Spares
- Number of Read/Write Heads 10
- Interchangeable Disc Packs . . . . IBM 1316 or Memorex Mark I

First Customer Shipment—May, 1969



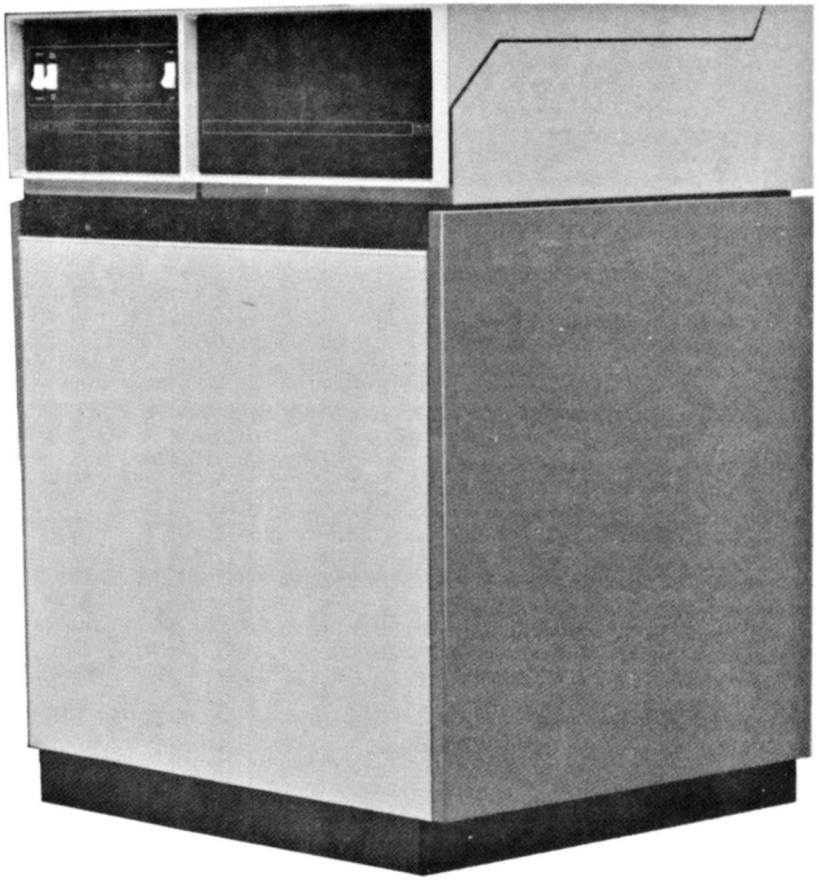
630
Disc Drive

IBM 2311 Model 1 Compatible

Connects to IBM 2841 Storage Control

- Spindle Rotation Rate . . . . . 2400 RPM
- Average Access Time . . . . . 50 Milli Seconds
- Pack Capacity . . . . . 7.25 Million Bytes
- Number of Tracks Per Surface . . . . . 200 Plus 3 Spares
- Number of Read/Write Heads 10
- Interchangeable Disc Pack . . . . . IBM 1316 or Memorex Mark I

First Customer Shipment—June, 1968

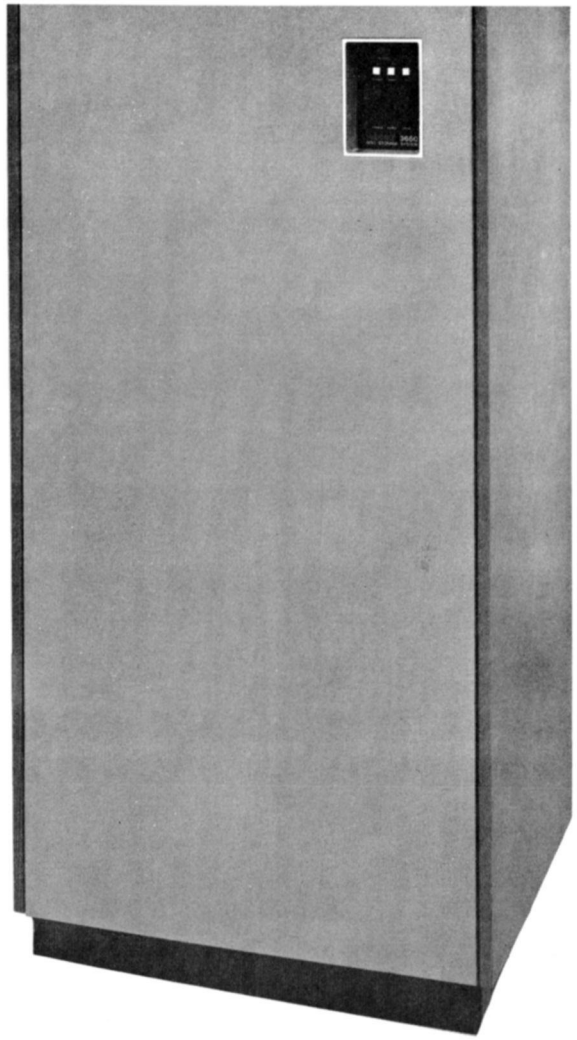


3660
Disc Drive

Connects to IBM 360/370 Systems Through Memorex 3661 Control Unit

- Spindle Rotation Rate . . . . . 2400 RPM
- Average Access Time . . . . . 35 Milli Seconds
- Pack Capacity . . . . . 29 Million Bytes
- Number of Tracks Per Surface . . . . . 200 Plus 3 Spares
- Number of Read/Write Heads 20
- Interchangeable Disc Pack . . . . IBM 2316 or Memorex Mark VI

First Customer Shipment—June, 1970

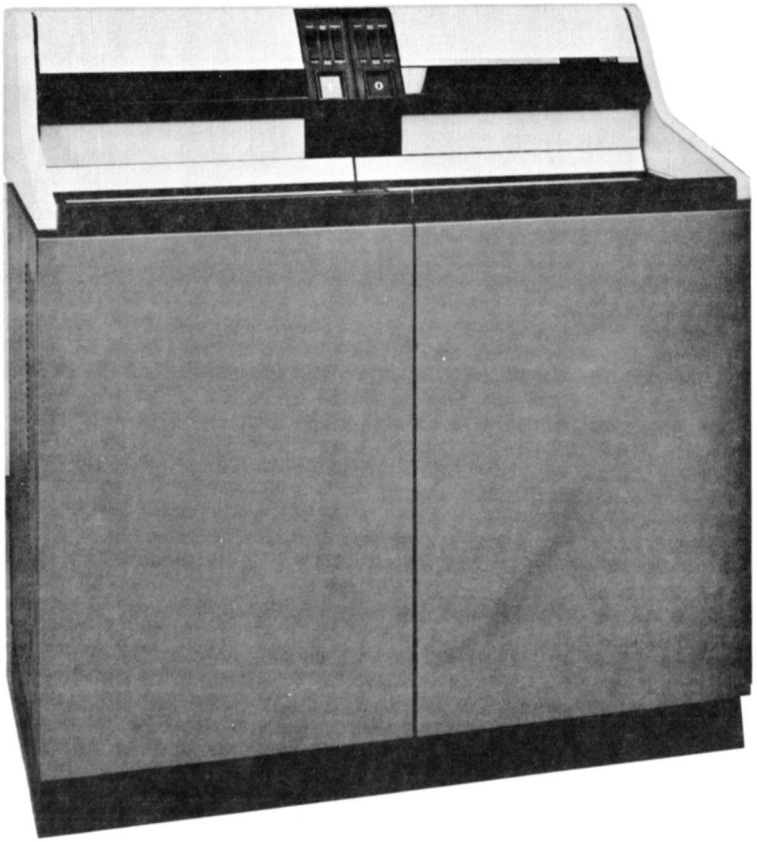


3661
Storage Control Unit

IBM 2314 Compatible
Connects to IBM 360/370 Selector Channel

- Type of Control Storage . . . . . Read Only Memory (ROM)
- Machine Cycle Time . . . . . 500 Nano Seconds
- Data Transfer Rate . . . . . 312,000 Bytes/SEC
- Type of Disc Drive Controlled 660-0
- Number of Disc Drives Attachable . . . . . 9 Maximum
- Features Available . . . . . Two Channel Attachment

First Customer Shipment—June, 1970



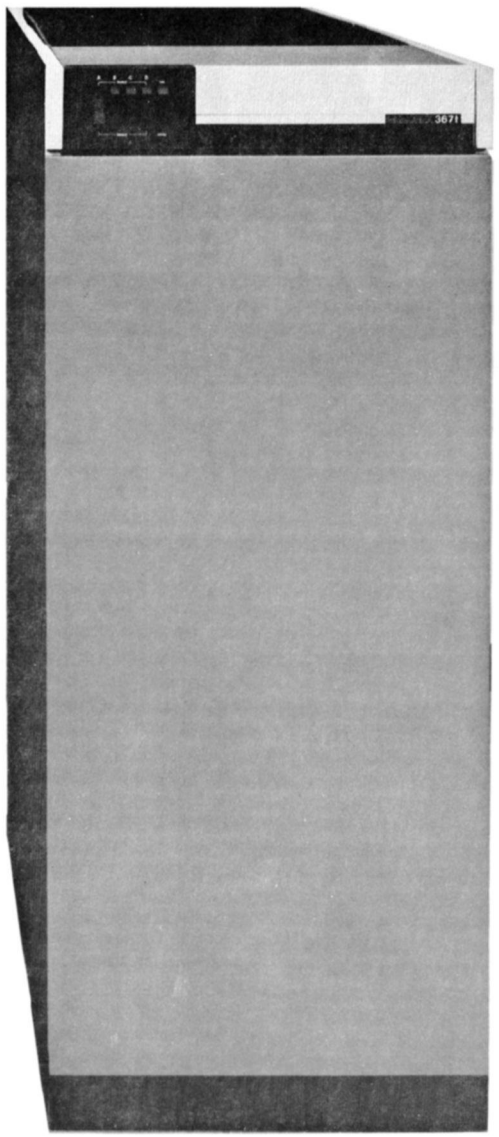
3670
Disc Drive

IBM 3330 Model 1 or 2 Compatible

Connects to IBM 360/370 Systems through Memorex 3671, 3672/3673, or Equivalent Control Unit

• Spindle Rotation Rate	3600 RPM
• Average Access Time	27 Milli seconds
• Pack Capacity	100 Million Bytes
• Number of Tracks Per Surface	404 plus 7 Alternate Tracks
• Number of Read/Write Heads	19 plus Servo
• Interchangeable Disc Pack	IBM 3336 or Memorex Mark X

First Customer Shipment—October, 1972



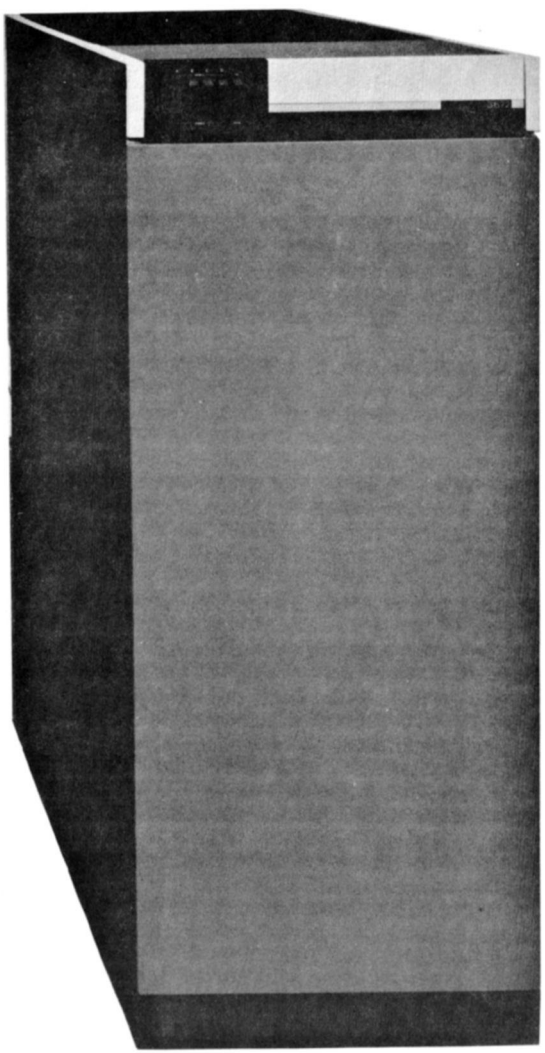
3671 Microprogrammed Storage Control Unit

IBM 3830 Model 1 Compatible

Connects to IBM System 360/370 Block Multiplexer Channel or System/360 Selector Channel

- Type of Memory . . . . . Read/Write (LSI Semiconductor)
- Machine Cycle Time . . . . . 240 Nano Seconds
- Data Transfer Rate . . . . . 806,000 Bytes/SEC
- Type of Disc Drive Controlled. 3670 Model 1 or 2
- Number of Disc Drives Attachable 8 Maximum
- Features Available . . . . . Two, Three, or Four Channel Attachment
  System/360 Attachment

First Customer Shipment—September, 1972

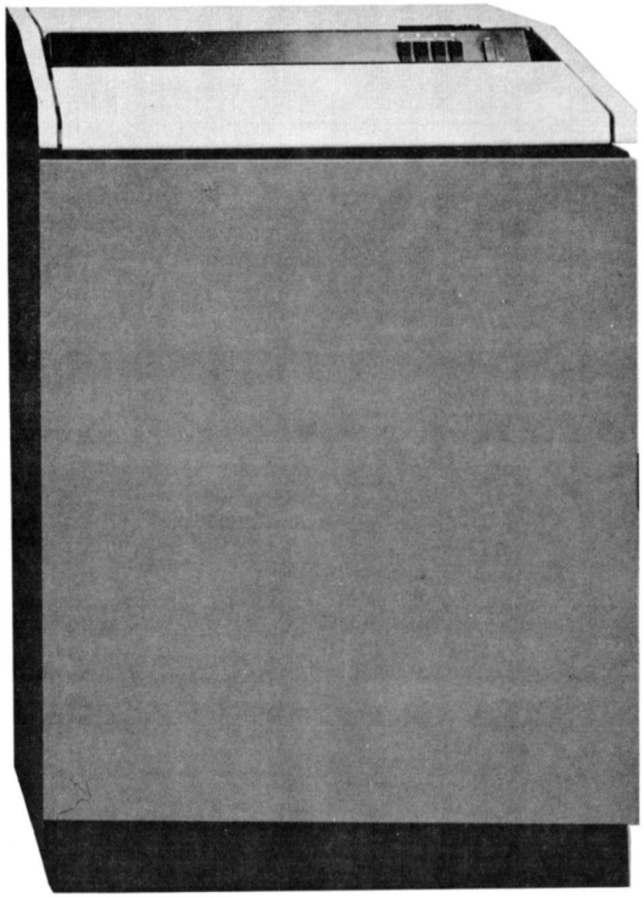


3672 Microprogrammed Storage Control Unit

IBM 3830 Model 2 Compatible
Connects to IBM System 360/370
Block Multiplexer Channel

- Type of Memory . . . . . Read/Write (LSI Semiconductor)
- Machine Cycle Time . . . . . 240 Nano Seconds
- Data Transfer Rate . . . . . 806,000 Bytes/SEC
- Type of Disc Drive Controlled . . 3670/3675
- Type of Disc Controller Required 3673
- Number of Disc Drives Attachable 32 Maximum (4 Strings)
- Features Available . . . . . Two, Three, or Four Channel Attachment

First Customer Shipment—September, 1974



3673
Disc Controller

IBM 3333 Model 1 and 11 Compatible (without Drives)

Connects to IBM IFA, DDA, ISC, or 3830-2 or 3 Controllers, and Memorex 3672 Controller

• Data Transfer Rate	806,000 Bytes/SEC
• Type of Disc Drive Attached	3670/3675
• Number of Disc Drives in String	8 Maximum
• Features Available	Two, Three, or Four String Switch

First Customer Shipment—April, 1974

CALCOMP1144 Storage Control Unit

UNIVAC Fastrand II Drum Subsystem Compatible

Connects to UNIVAC Systems 400 & 1100

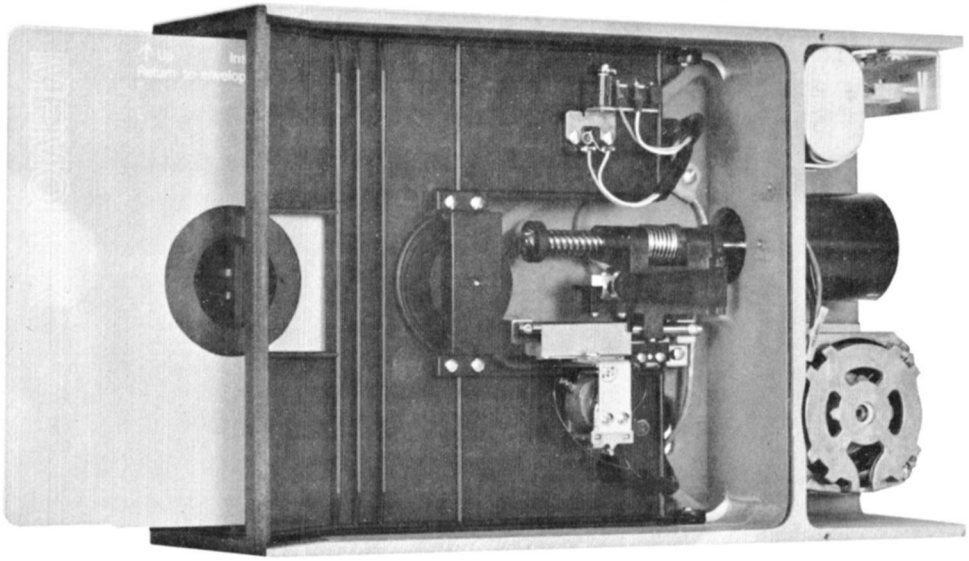
- **Type of Memory . . . . . RAM**
- **Machine Cycle Time . . . . . 200 Nano Seconds**
- **Data Transfer Rate . . . . . 312, 500 Bytes Per Second**
- **Type of Disc Controlled . . . . . 244 Disc Drive**
- **Number of Discs Controlled 24**
- **Features Available . . . . . One Per Channel**

CALCOMP 244 Disc Drive

Connects to UNIVAC 400/1100 Systems Through Intranet 1144 Control Unit

• Spindle Rotation Rate	2400 RPM
• Average Access Time	32 msec
• Pack Capacity	58 Million Bytes
• Number of Tracks Per Surface	400
• Number of Read/Write Heads	20
• Interchangeable Disc Pack	IBM 2316 or Memorex Mark VI

First Customer Shipment—July, 1973



650
Flexible Disc

A product line sold to Original Equipment Manufacturers (OEM's) for incorporation into their end-user products.

The flexible disc represents an improvement in reliability and access time compared to tape cassettes, and a substantial cost savings compared to other rotating magnetic disc drives which use hard-surfaced aluminum disc substrates. The flexible disc drive is gaining wide acceptance as a storage device in data entry, word processing, or remote terminal products, and for control storage loading/unloading.

Features:

- IBM-compatible or non-IBM compatible versions
- Removable, low-cost, mailable media
- OEM's may provide power supply, covers, electronics, diagnostics, and software support
- 65,000 bytes to ¼ million bytes, or more, storage capacity
- Rotational Speed—375 RPM

MRX/50
Small Commercial Computer System

Provides Upward Compatibility for 360/20

Central Processor Features Include:

- **MOS Semiconductor Storage . . . . . 1024 LSI Chips Up to 128K Bytes, 900 Nano Second Cycle**
- **Microprogram Read/Write Control Storage . . . . Enables Shared Resource Concept with Eight Processor States for Parallel Autonomous Processing**
- **Integrated Input and Output Control . . . . . Provides Direct Attachment of Communications, Disc, Unit Record and Console Units**
- **Optional 360/370 Selection Channel . . . . . Enables Direct Attachment of 360/370 Channel Compatible Devices**
- **Industry Standard Software . . . . . COBOL, RPG, Fortran Compilers**
- **Large Disc Storage Capability . . . . . 30MB Discs Standard, 100/200MB Optional**

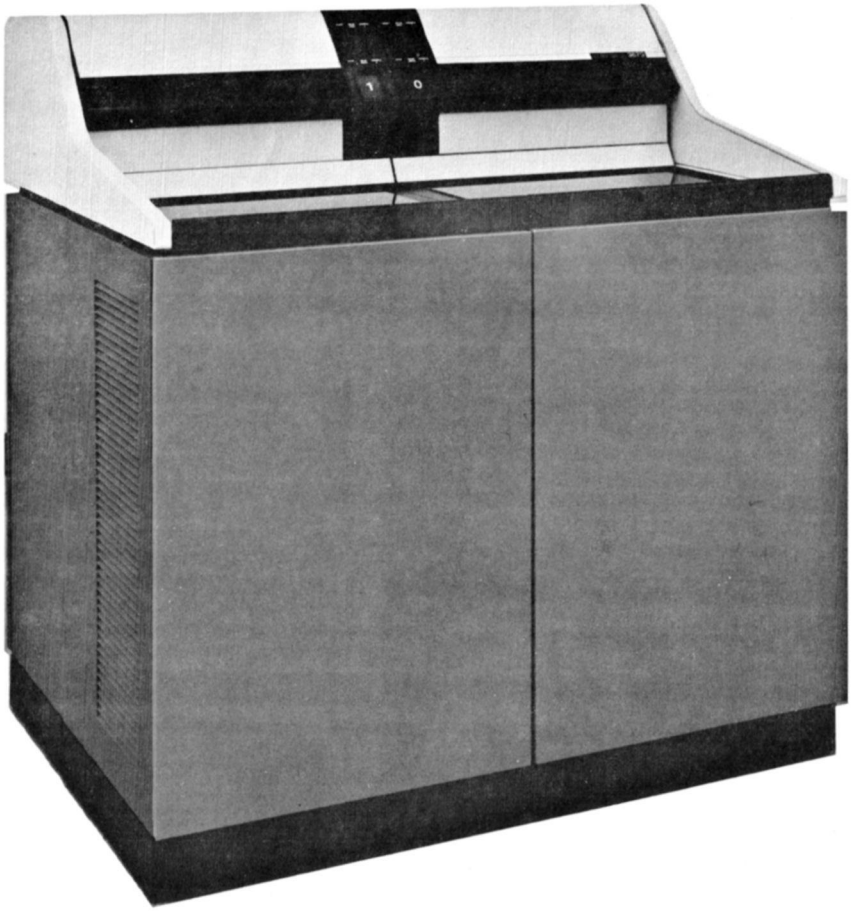
First Customer Shipment—September, 1972

INFOREX

Off-line Data Entry Subsystem

A cluster of keyboard and display stations for operator recording of data in machine-readable form. A central control unit holds the data in a disc buffer until checked for accuracy, then writes the records sequentially on compatible magnetic tape for manual transfer into the computer room.

- **Input . . . . . Operator Key Entry**
- **Number of Stations . . . . . One to Sixteen**
- **Output . . . . . Magnetic Tape**
- **Usage . . . . . Off-line Data Entry**



3675
Disc Drive

IBM 3330 Model 11 Compatible

Connects to IBM 360/370 Systems Through Memorex 3672/3673 or Equivalent Control Units

- Spindle Rotation Rate . . . . . 3600 RPM
- Average Access Time . . . . . 27 Milli Seconds
- Pack Capacity . . . . . 200 Million Bytes
- Number of Tracks Per Surface . . 808 plus 7 Alternate Tracks
- Number of Read/Write Heads . . 19 plus Servo
- Interchangeable Disc Pack . . . . IBM 3336-11 or Memorex Mark XI

First Customer Shipment—October, 1974

GLOSSARY OF TERMS

Omitted hereinafter