

HAZELTINE DIGITAL VIDEO DISPLAY SYSTEMS



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INTERLOCK

Hazeltine has been a leader in Digital-Video Display Systems since 1962

Hazeltine's Digital-Video Display Systems convert computer-generated digital data into television video signals which produce displays on TV monitors. These TV displays consist of alphanumeric, vectors, symbols and curves, in accordance with instructions from the computer. The Display Systems include Data Entry controls at the displays to enable operators to modify their displays and to order programmed computer routines.

Since their introduction in 1962, these Systems—earlier known as Alpha-Numeric Generators (ANG) and Digital Display Generators (DDG)—have been undergoing continuing development. The result is smaller, less costly and more reliable equipment incorporating micrologic components and containing advanced functions and features.

Digital-Video Display Systems include a number of different types of varying complexity, ranging from elaborate systems for air traffic control, to simple desk-top, stand-alone alphanumeric displays. All types are based on a common technical approach; they differ in the omission or emphasis of particular functions or features.

Model ANG-3 is the largest and most complex system in the Hazeltine line. ANG-3 is a major component at three Federal Aviation Administration Air Traffic Control installations: John F. Kennedy International Airport, New York; Jacksonville, Florida; and Atlantic City, New Jersey. Predecessor Models ANG-1 and ANG-2 are similar in size and complexity, and are operational at the Atlanta, Georgia Air Traffic Control Terminal.

The installation at Kennedy International, in Hangar 11, is the Common Instrument Flight Rules Room (CIFRR), the first of its kind in the world. The CIFRR combines, in one center, the control of air traffic in the Kennedy, LaGuardia and Newark terminal areas. Control of these areas was formerly performed by separate traffic control installations at the individual airports.

An overall view of the CIFRR is shown at left. The inset photo on the cover is a closeup of several Air Controllers' displays in the Room. The background photo, spanning front and back covers, is a closeup of a typical display, showing alphanumeric tagging of aircraft by the ANG-3.

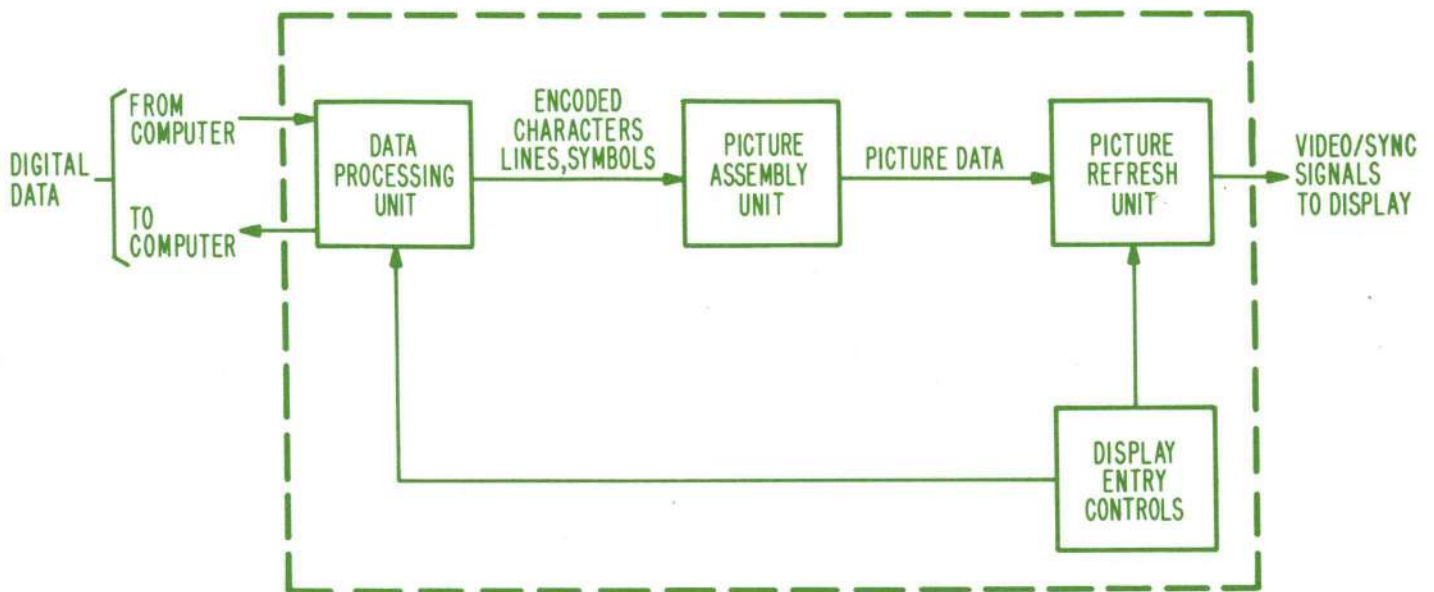
Model DDG-1, a second type of Digital-Video Display System, has been applied successfully to the problem of



pre-launch checkout of space rockets. Several of these systems are installed at Cape Kennedy, as part of the National Aeronautics and Space Administration facilities there. Microwave links carry DDG-1 video outputs to displays at NASA's Manned Space Flight Center, in Houston.

Model DDG-2 of the Digital-Video line is operational at Brookhaven National Laboratory, Long Island, New York, where it is part of a research facility.

The versatility of Hazeltine Digital-Video Display Systems is such that they are particularly well-suited for a wide variety of applications—military, industrial, commercial and for the professions. Since functional requirements vary, depending upon the specific application, Hazeltine has available several different basic types of Systems, and will tailor each to fit specific customer requirements.



Hazeltine Digital-Video Display System

Capabilities of Hazeltine Digital-Video Display Systems

Hazeltine Digital-Video Display Systems, which can interface with any type of digital computer, convert computer-generated digital data into video signals. When fed to TV monitors, these video signals produce continuous, flicker-free displays of letters, numerals and characters of any shape or size, symbols, lines, curves and maps, in random or regular order and format, in accordance with computer instructions.

A single Digital-Video Display System can produce any number of different displays concurrently, via independent video channels. Each channel may feed one or more local and/or remote TV monitors and/or large-screen displays. In practical applications, the number of such channels may exceed 100.

The system is capable of extremely fast display updating of large quantities of data—as many as 30 full display updates per second—all the while accepting computer data in random or regular order and timing. Special functions readily incorporated into the design include coordinate conversion, selective update and erase, shifting graphical functions and ripple-firing of data.

Principles of Operation— Comparison to Conventional TV

In conventional TV, the camera tube records the scene electrostatically on an image plate. The electrostatic charges are then read out, to produce the video signal.

In digital TV, the Hazeltine System converts the input digital data into an image of the desired display by means of a dot-by-dot construction process on an image plate consisting of a core memory. The core memory is then read out in a scanning sequence to produce the video signal. Typically, there is one core in the core memory for each picture element in the display. A standard 525-line TV system, for example, containing 1,000 dots on each of 480 active TV lines, is thus seen to require a core array of 1,000 x 480 cores.

Digital TV systems have a higher display resolution than commercial systems. In commercial TV, the “Kell Effect”—which can be compared to the effect of viewing a scene through partially closed venetian blinds—causes loss of resolution. In digital systems, there is no such problem. Images are sharp. Addressability of 10^6 picture elements (1000 x 1000) is achieved.

Digital-Video System Logic

The **Data Processing Unit** accepts information in any sequence from the computer—in the form of digital words representing alphanumeric, symbols and lines, with X and Y coordinate display addresses and other appropriate instructions. These words are stored in the **Input Buffer Memory**.

After decoding, the words are transferred to the **Picture Assembly Unit**, where the bits are stored in the **Core Memory** in a geometric pattern duplicating the desired display pattern. This process continues until a complete picture is formed and stored.

The picture is then read out destructively to the **Drum Memory** in the **Picture Refresh Unit**, from which it is played out repetitively through a parallel-to-serial conversion process, to the TV display.* Read-out occurs at a standard 30 Hz frame rate. (Each frame has two interlaced fields.)

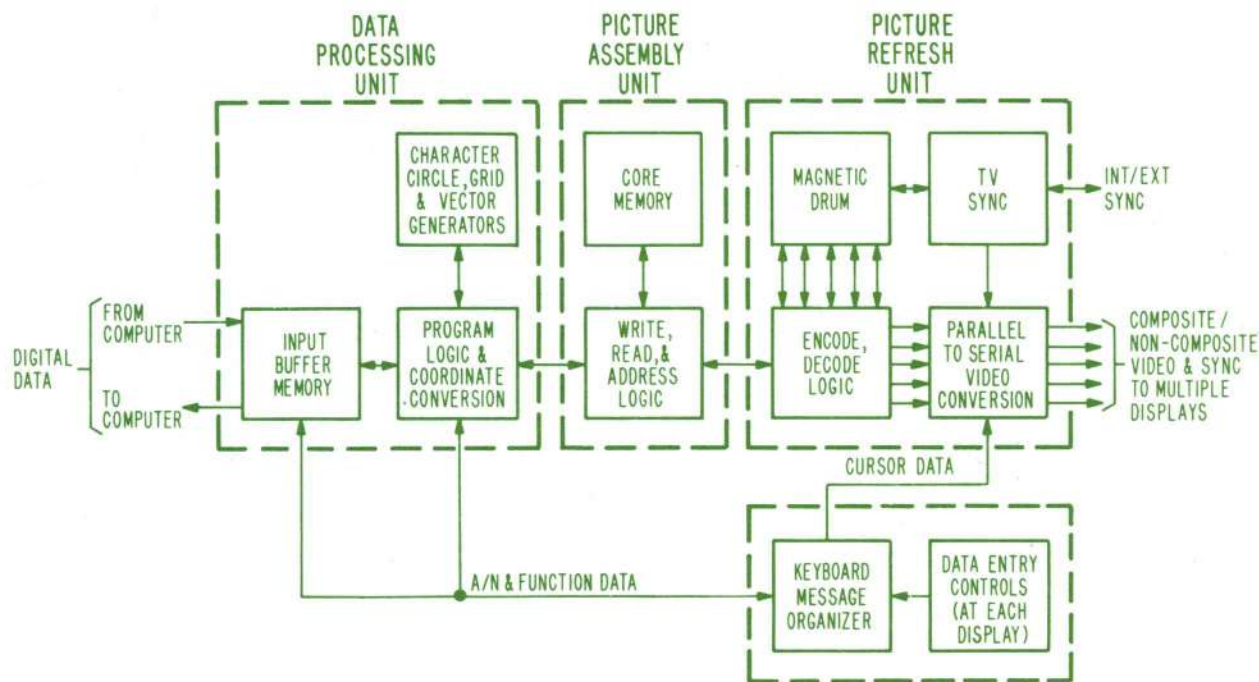
For multiple displays, pictures are assembled sequentially in the **Core Memory**, and are transferred to different sections of the **Drum Memory**, from which they are read out simultaneously to the many displays.

Display Controls, for data entry, are in the form of alphanumeric and function keyboards, trackballs and light pens—all supplied by Hazeltine as part of the system. These controls interface with different parts of the Digital-Video System.

For example, the trackball—which moves and positions a cursor symbol on the operator's display—interfaces with two parts of the system: the video electronics of the Digital-Video equipment, to obtain instant response on the display; and the external computer, via the **Data Processing Unit**, to transmit cursor coordinates.

Alphanumeric and function keys interface similarly, depending on user requirements.

*The **Picture Refresh Unit** may incorporate a disc memory, a core memory or a drum memory, depending upon operating requirements.



Advantages of Hazeltine Digital-Video Systems

Lowest Cost for multiple display systems, derived from the use of a single system to furnish video to inexpensive TV monitors.

High Quality Displays, sharp and clear, free of the "Kell Effect," free of flicker and smear. Selective or complete update and erase occur instantaneously on the display, without display interruption or blinking during updating.

Brightness is uniform, independent of type or quantity of data displayed, and does not change at overlapping points of data (each picture element is written once per frame). Display linearity is independent of displayed data. Two brightness levels are available, independently adjustable.

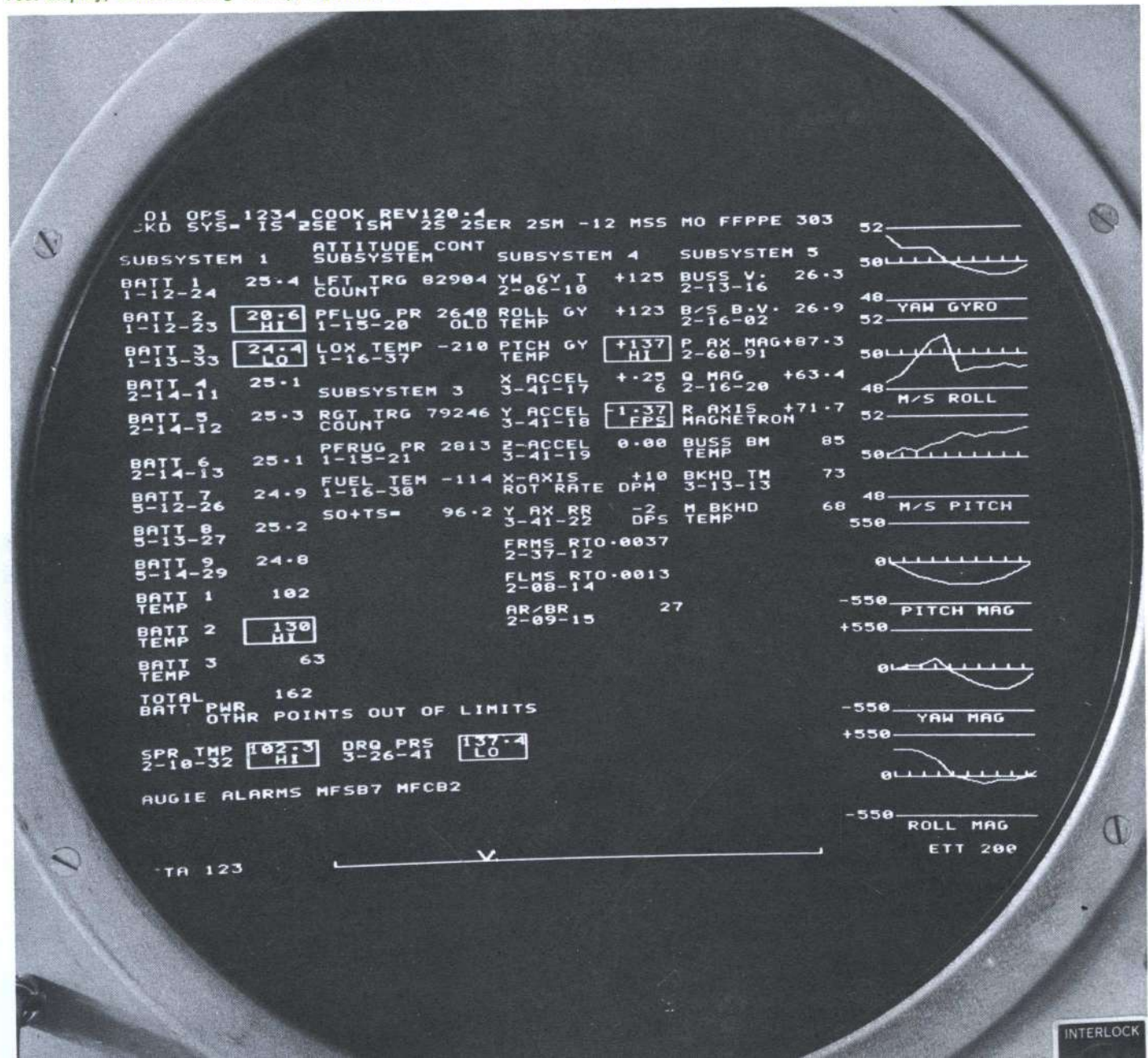
All Types of Data may be generated and displayed—letters, numerals and characters of any size or shape, symbols, lines, curves and maps, compatible with desired display resolution.

Interfacing Flexibility—with any make or type of digital computer.

High Quantity of Displayed Data—any amount of sequential or randomly-plotted data up to a completely white screen, without degradation of any kind.

Flexibility and Growth Capability—The number of independent or slave displays can be increased simply and at low cost.

Test display, demonstrating variety, legibility, detail and clarity of displays achieved by Hazeltine Digital-Video Display Systems.



Simple video switching or computer data addressing techniques can be used to enable any TV monitor to display any picture generated by the system.

Remote displays may be operated, using a minimum of cabling in simple installations. Microwave links may be used to remote the video data over long distances.

Composites of two or more displays on a single display are obtained by simple video-mixing of the display channels—one of the available methods for superimposing various backgrounds on any given display. Other sources of synchronized video (TV camera, scan converter, etc.) may likewise

be mixed with the digital TV video onto a single display.

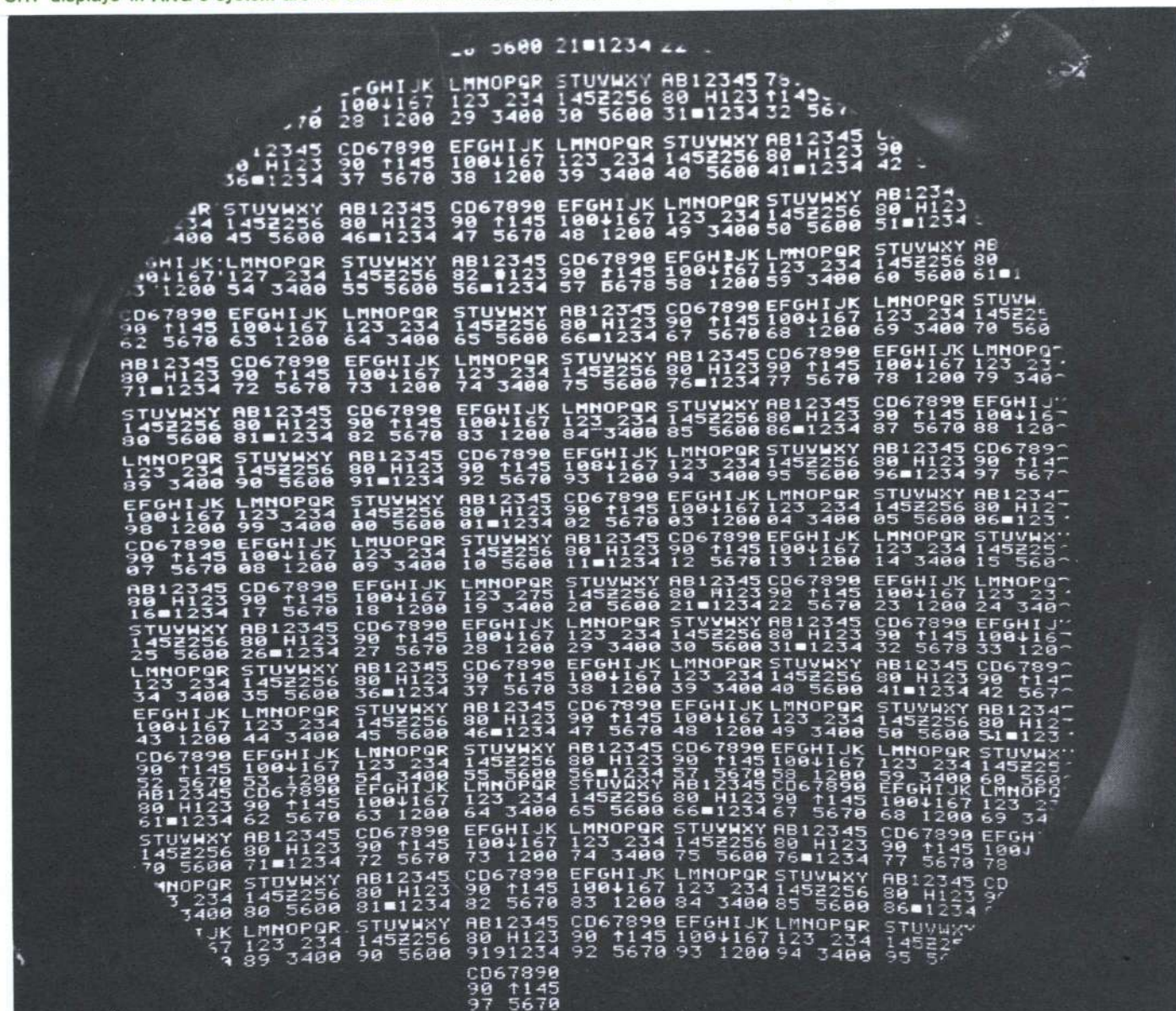
Color displays are obtained by video-mixing two or three suitably programmed display channels into a color monitor.

Large-screen displays are obtained by feeding the video signals, unchanged, to standard TV projection displays.

All video-mixing of data is accomplished with zero registration error on the displays.

Data Entry Controls— alphanumeric and function keyboards, cursor controls—enable display operators to edit display and communicate programming instructions to the external computer.

Typical Digital-Video Display, demonstrating tight-packing of characters. Approximately 4,000 characters are shown. CRT displays in ANG-3 system are 16 and 22 inches diameter, have a 6,400-character capacity.



Digital-Video Display System Model ANG-3

Application: Air Traffic Control

A major component of the FAA Air Traffic Control System, ANG-3 accepts coded digital data from the system computers, and data entries from air traffic controllers' display controls, and generates electronically-written flight data on the controllers' CRT and large-screen displays.

A typical CRT display—showing the alphanumeric tagging of aircraft—is shown on the cover.

A single ANG-3 provides 12 simultaneous and independent channels of 945-line TV video, at 20 MHz, to displays in the Common IFR Room at John F. Kennedy International Airport, New York. The CIFRR consolidates into one facility the air traffic control facilities that previously operated separately in the control towers at Kennedy, LaGuardia and Newark Airports. Included in the terminal control area are the air routes, holding areas and approach lanes over these three major airports.

The air controllers' displays—CRT's and two large-screen—consist of target blips and their alphanumeric identifications and vectors. The large-screen projections serve as a common reference source for all control teams, thereby facilitating the coordination and management of overall operations.

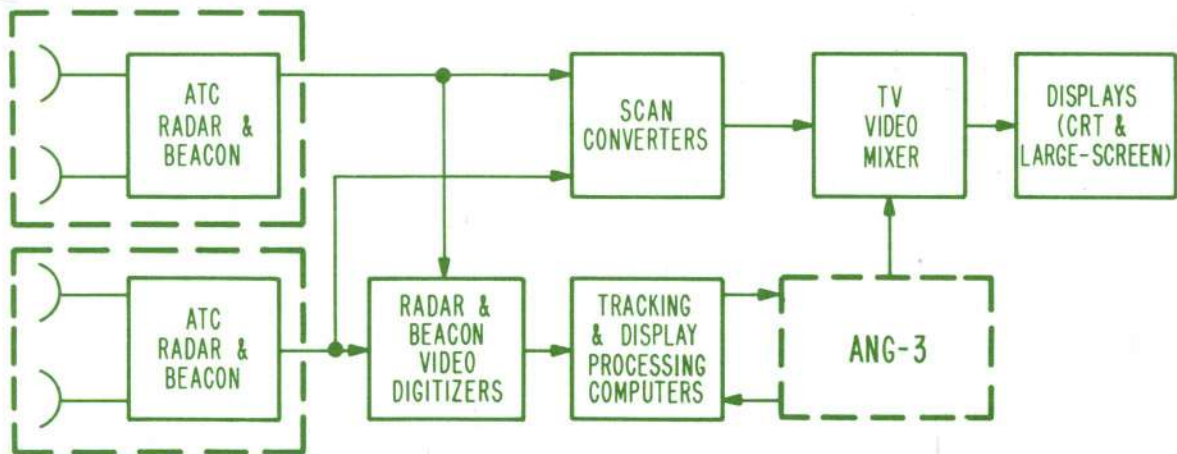
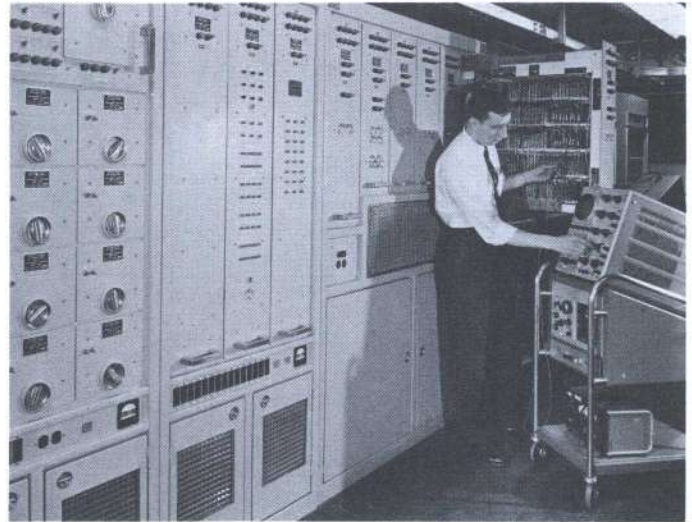
The blips are derived directly from radar and beacon data via scan converters (upper path).

Alphanumeric functions are provided by the lower path, containing ANG-3. The same radar and beacon data are first digitized and fed to the tracking and display processor computers. The output from these computers, organized

into 32-bit words, are bulk-transferred, at 90 kilowords/sec., into the 3200-word buffer memory section of ANG-3's Data Processing Unit. ANG-3 does the rest, in accordance with the program logic schedule.

In response to inputs from the computer, ANG-3 updates all displays with current data every 0.6 to 2.5 seconds. Multiple sets of data entry controls are furnished at each display to enable the air traffic controllers to modify their displays independently, and to call up various computer functions, such as tracking and hand-off.

Hazeltine Field Engineer Checks ANG-3 Main Equipment Circuits.

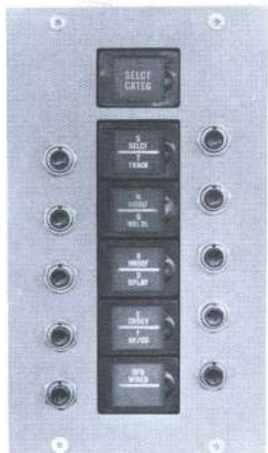


Principal Features of Digital-Video Model ANG-3

- Generates and positions alphanumeric data blocks adjacent to tracked aircraft, and special horizontal indicator bars above the data blocks, from target data received from the System computers. Data blocks indicate aircraft identity, altitude, speed, and beacon code. Bars indicate special aircraft status, such as attention, emergency and hand-off.
- Repositions data blocks, and deletes any and all parts of the blocks and indicator bars, in response to instructions from the computer and data entry actions by air traffic controllers, to minimize display clutter.
- Generates and positions tabular data in preselected areas of the displays, denoting pending and holding aircraft, from data received from the computers and data entry controls.
- Generates velocity vectors indicating aircraft headings and future positions, for prediction of potential conflicts.
- Receives computer data and controller entries, in both system (geographical) and display (TV position) coordinates, and automatically performs range-scaling and off-centering to address and position data to the correct sector and tabular displays.
- Updates and repacks tabular data as a result of changes in aircraft status.
- Updates all displays every 0.6 to 2.5 seconds.
- Generates background maps on displays.
- Provides data entry at the displays and interface with the computers, enabling each air traffic controller to initiate or modify computer operations and displayed data.
- In addition to providing the above special purpose functions, the ANG-3 also generates random or sequential data, in response to computer instructions.

ANG-3 Air Controllers Data Entry Controls.

Category/Function Module



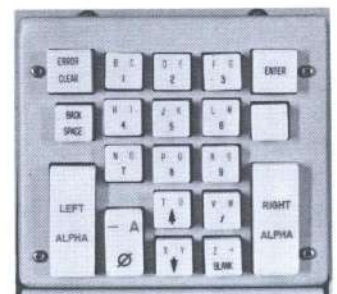
Trackball



Display Control



Alphanumeric Keyboard



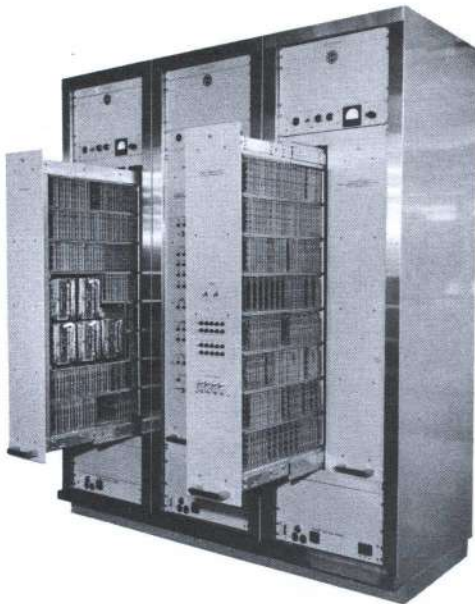
Digital-Video Display System Model DDG-1

Application: Pre-Launch Checkout of Rockets and Space Vehicles

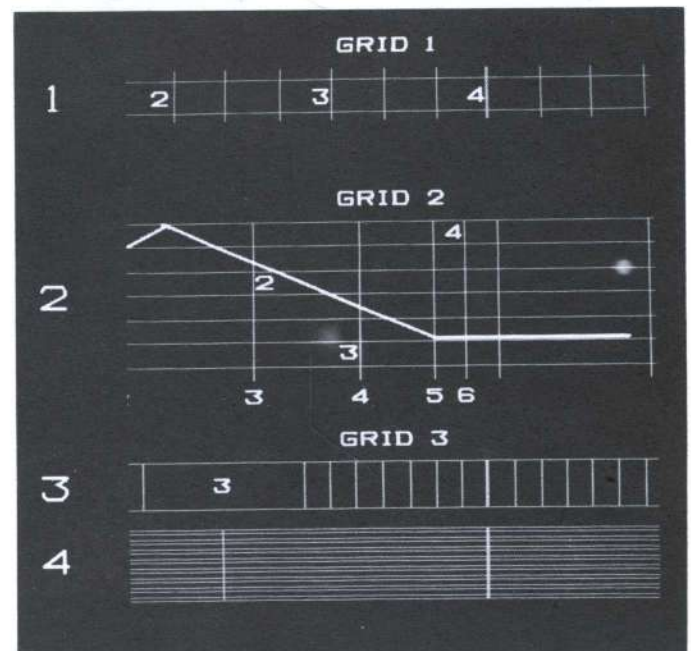
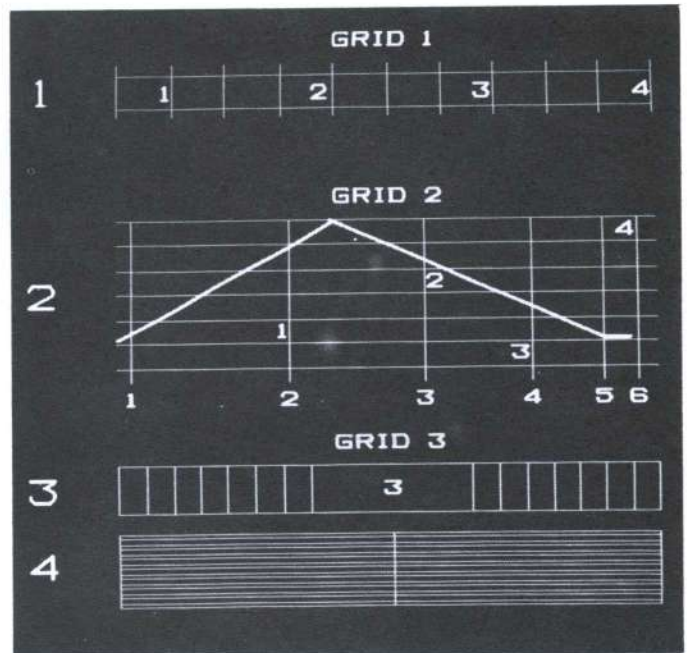


Several Hazeltine Digital-Video Systems, Model DDG-1, are installed as part of NASA's Cape Kennedy rocket support and checkout complex. Their function is to provide tabular and graphic displays of digital data transmitted by sensors located at the launching pads. Such data consists of continuous measurements of the rocket's many operating parameters during countdown. Each DDG-1 provides ten independent displays.

DDG-1 is similar to ANG-3, except for the input buffer (of the Data Processing Unit) and data entry controls, which were already part of the NASA installation and were therefore unnecessary in the Hazeltine System.



Model DDG-1 Digital-Video Display Equipment.



Sequential displays demonstrating right-to-left shift of graphs and data. (Note regeneration of graph lines in bottom photo.)

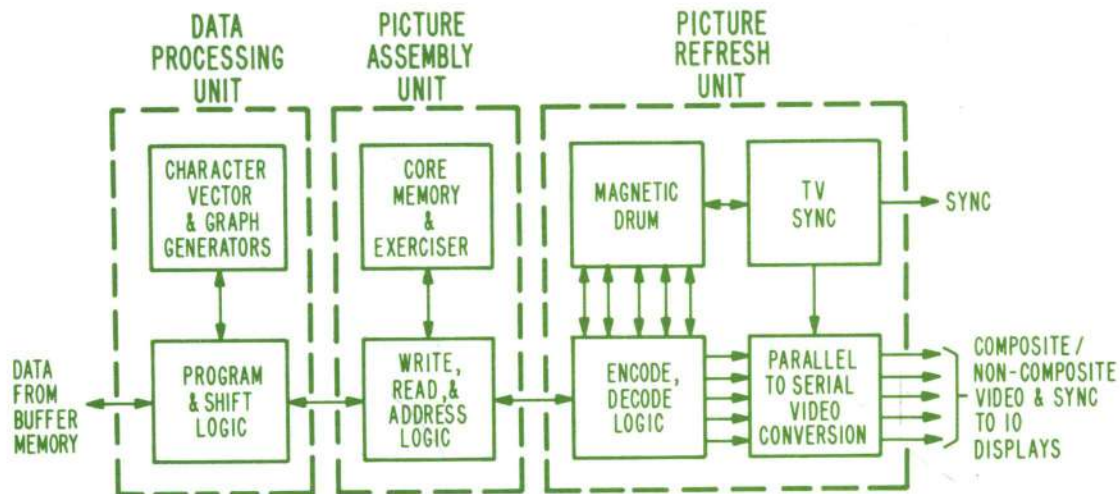
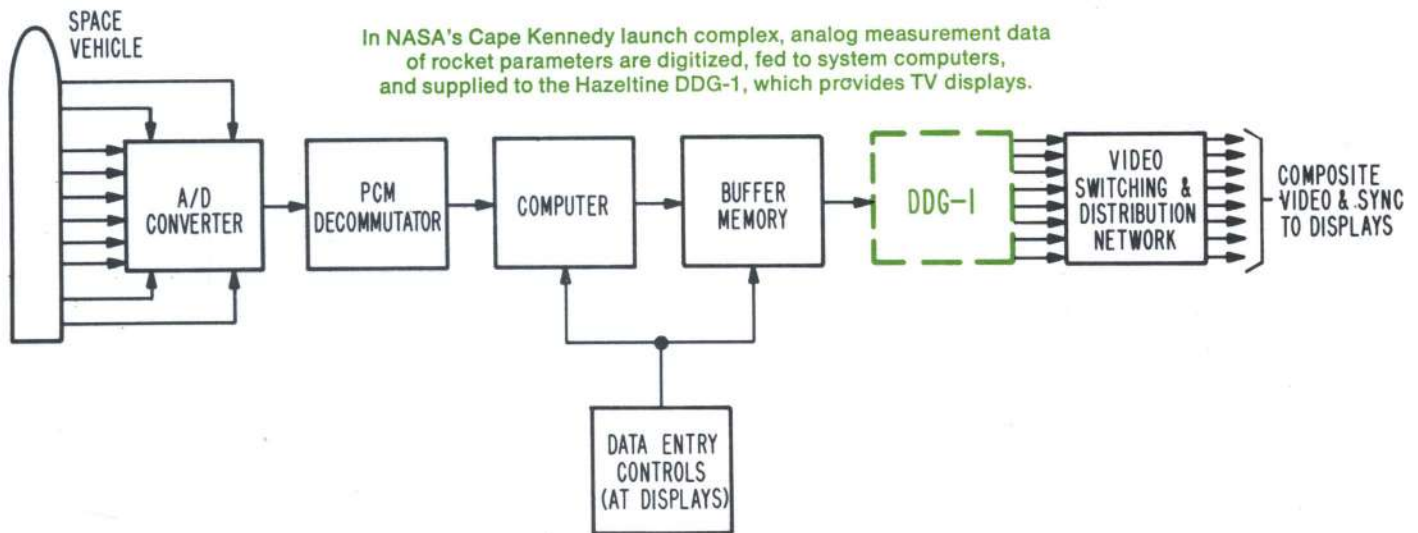
Features of the DDG-1

- Displays measurement data in text mode (alphanumerics and symbols), or in graphic mode.
- For the text mode, adapts to a wide variety of tests by providing a large repertory (128) of characters and symbols, changeable in size (up to 32 x 32 matrix) and font by computer or manual control.
- For the graphic mode, provides storage and generation of eight background graphs, as composed by the computer or by manual control.
- Displays background graphs at approximately half the brightness of the measurement data.
- For the graphic mode, provides simultaneous displays of up to four graphs and plots measurement data on each display.

play. (Each graph occupies a separate area of the display surface.)

- For the graphic mode, provides right-to-left shift of graphs and data, per single computer instruction. (Oldest data and grid lines disappear at the left, newest data and recirculating grid lines appear at the right. Appearance is that of moving strip charts past a fixed window to continuously discard oldest data and maintain current data visible. Alphanumeric graph titles do not shift.)

- Provides non-destructive data storage, together with selective display update and erase, enabling pre-launch check-out process to resume following long hold periods, without requiring the computer to reconstruct display data base.



DDG-1

Digital-Video Display System Model DDG-2

Application: Scientific Research

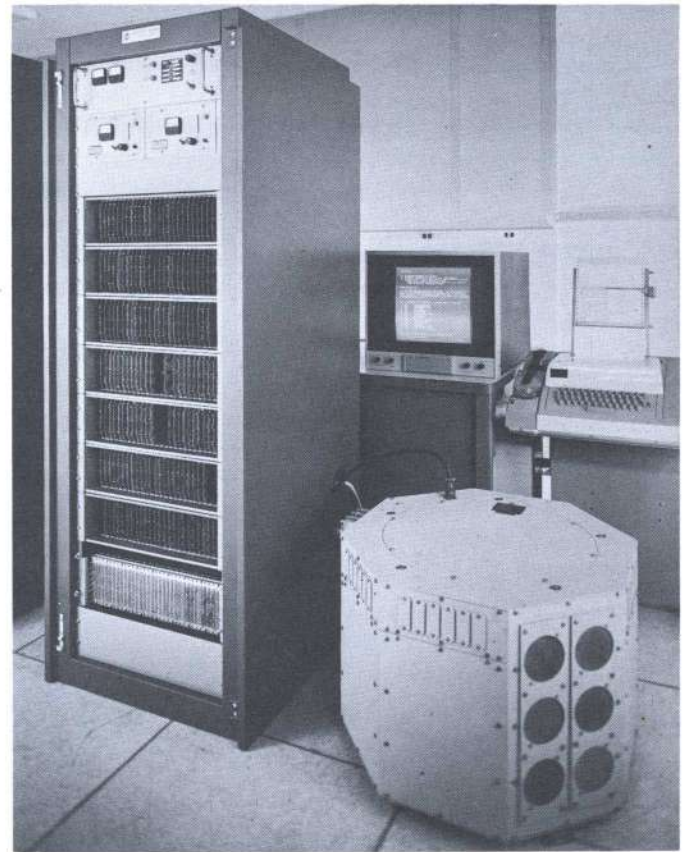
Model DDG-2 is used at Brookhaven National Laboratory, Upton, New York, in conjunction with continuing research into atomic nuclei. It provides digital displays, together with alphanumeric text data, representing atomic events occurring in a bubble chamber.

The DDG-2 meets the system's requirements that the display presentations of the scatter diagrams, containing as many as 32,000 randomly-plotted points, be bright, accurate and flicker-free.

Although the DDG-2 has capacity for 32 independent display channels, the initial requirement at the Laboratory was only for two. As installed, the Brookhaven DDG-2 provides for these two independent displays, with built-in expansion capacity for up to 32.

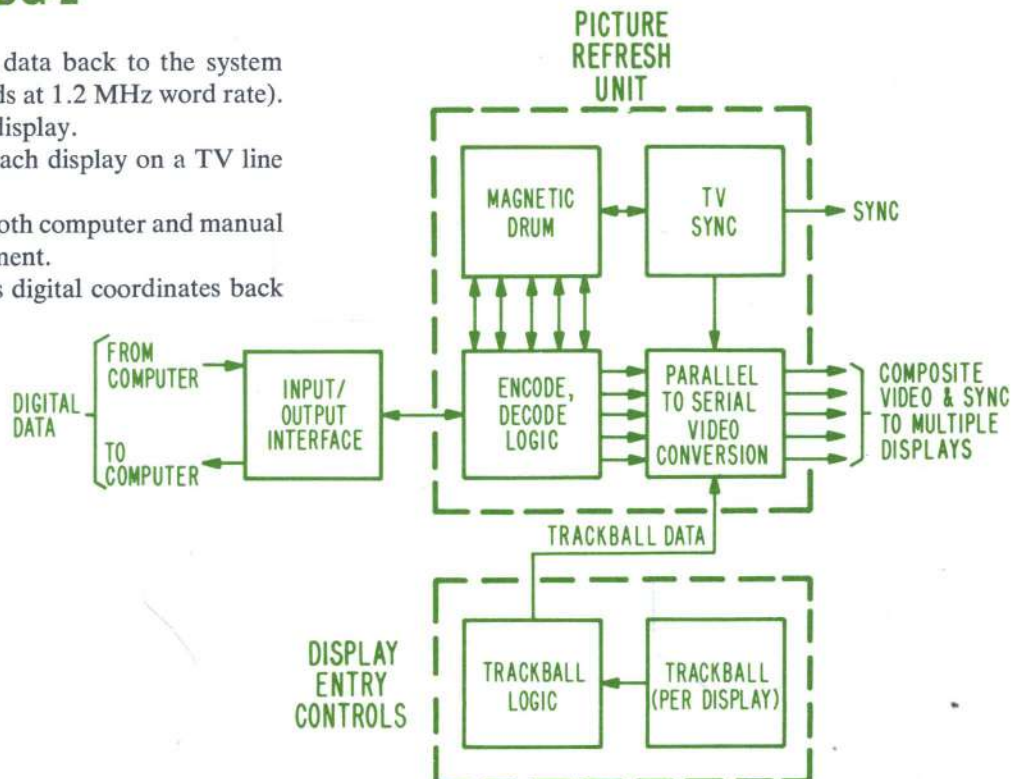
Since, in this application, there is no requirement for high-speed updating of data, one of the system computers is used to produce the picture video format for each display. Thus, there was no need for a Data Processing Unit or for a Picture Assembly Unit. The Picture Refresh Unit interfaces directly to the central computer.

In this much simplified version of the Digital-Video System, therefore, the DDG-2 serves primarily as the picture storage and refresh unit for what may eventually become a system composed of 32 display channels.



Other Features of Digital-Video Model DDG-2

- Accepts data and reads stored data back to the system computer at high speed (8-bit words at 1.2 MHz word rate).
- Provides full updating of each display.
- Provides selective updating of each display on a TV line basis.
- Provides a cursor, movable by both computer and manual control, to any display picture element.
- Converts and transmits cursor's digital coordinates back to the system computer.



Specifications for three typical Hazeltine Digital-Video Display Systems

	ANG-3 Air Traffic Control	DDG-2 Atomic Research	DDG-1 Rocket/Space Vehicle Pre-Launch Checkout	
DISPLAY PARAMETERS	TV Line Standard	945	549	525
	Resolution (HxV)	512 x 800	512 x 512	1024 x 480
	Display Size	Any TV Monitor	Any TV Monitor	Any TV Monitor
	Max. No. of Characters	6,400	4,100	6,800
	Repeatability	< .1 Spot Size	< .1 Spot Size	< .1 Spot Size
	Jitter	< 5 nanosec	< 5 nanosec	< 5 nanosec
	Gray Levels	1	1	2
OUTPUT VIDEO/SYNC.	No. of Video Channels	12	Up to 32	10
	Video Bit Rate	20 MHz	10 MHz	20 MHz
	Video/Sync.	Separate	Composite	Separate & Composite
	Sync. Source	External	Internal	Internal
	Video Output	75 ohm	75 ohm	75 ohm
INPUT INTERFACE	Computer Source	IBM 9020; UNIVAC 1219	SDS Sigma 7	Buffer
	Word Size	32-bit	8-bit	36-bit
	Word Rate	200 KHz	1.2 MHz	200 KHz
	Mode	Bulk transfer, any or all channels	Per word demand	Per word demand
FUNCTION GENERATORS	Character	64 fixed, 5x7 font	External	128 Programmable, 32 x 32 max. font
	Vector	Yes	External	Yes
	Background	External program	External	8 graphs, internally stored per ext. program
	Coordinate Conversion	Yes	No	No
OPERATING MODES	Random, Format, Tabular, Complete Update & Erase	Computer-Programmed	Complete Update & Erase, Selective Update & Erase, Shift	
MEMORY	Buffer (Core)	3.2K (32-bit)	None	None
	Video (Core)	12.8K (32-bit)	None	15.6K (32-bit)
	Refresh (Drum)	5 Megabits	8.5 Megabits	5 Megabits
	Exerciser	Separate	No	Internal
DATA ENTRY CONTROLS & LOGIC	A/N Keybd.; Cat./Func. Keybd.; Trackball; Display Ctl.; Keybd. Msg. Organizer	Trackball	Optional	
PHYSICAL	Drum Size	Internal to Cabinets	30" x 30" x 30"	30" x 30" x 30"
	Cabinet Size	82" H. x 124" W. x 36" D.	60" H. x 24" W. x 30" D.	88" H. x 92" W. x 30" D.
	Weight	4,100 lbs.	800 lbs.	3,000 lbs.
	Power	120V, 60Hz, 3 ϕ , 4.5 KW	120V, 60 Hz, 3 ϕ , 2 KW	120V, 60 Hz., 3 ϕ , 3.5 KW
	Environment	50°-100°F., 40%-90% R.H.	50°-100°F., 40%-90% R.H.	50°-100°F., 40%-90% R.H.

Hazeltine has designed, developed and produced more displays for the Government than any other company.

The photos on these pages represent a sampling of Hazeltine land-based, shipboard and airborne indicators—displaying sensor and/or computer information.

Hazeltine Corporation is presently developing a desk-top display terminal for those users in Government, commerce, industry and the professions who require rapid access to, and display of, computer-generated data. An operator, at each desk-top display, can interrogate, display and alter the stored computer information. The System consists simply of as many low-cost, stand-alone displays as may be required, each with its own built-in data processing logic.

If you have a display problem, be sure to speak to the men at Hazeltine. Direct your inquiry to the Marketing Department.

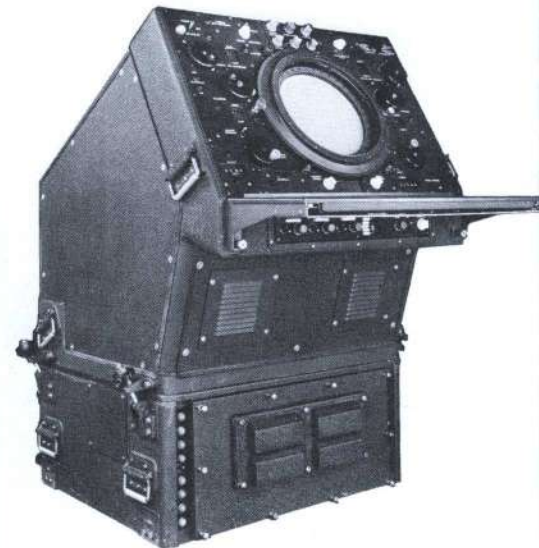


Hazeltine Corporation

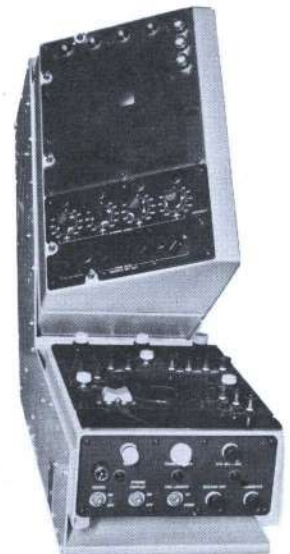
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Cable NEUTRODYNE Telex 0126166



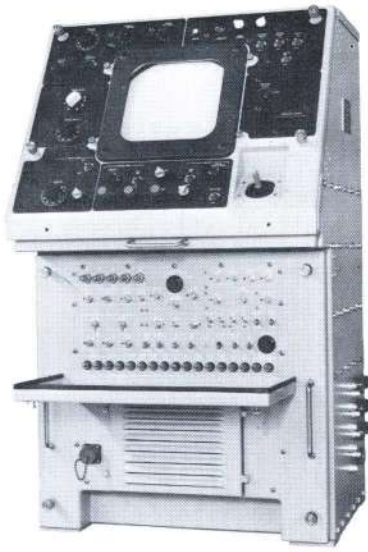
AN/SPA-66, U.S. Navy



AN/UPA-25, U.S. Marine Corps



AN/SPA-43, U.S. Navy



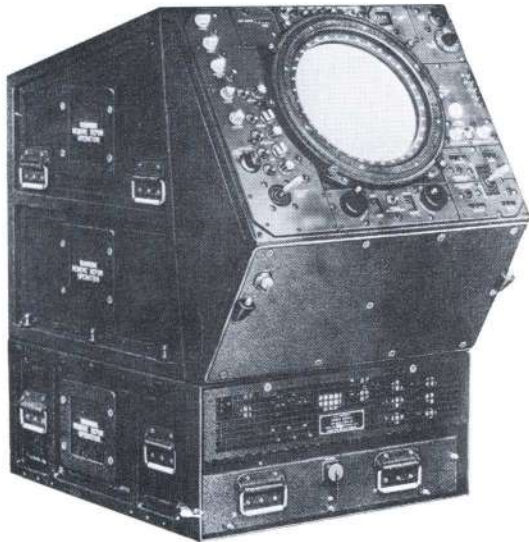
AN/SPA-41, U.S. Navy



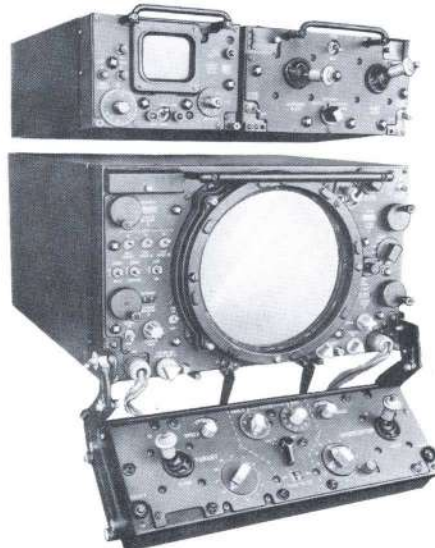
NTDS Console, U.S. Navy



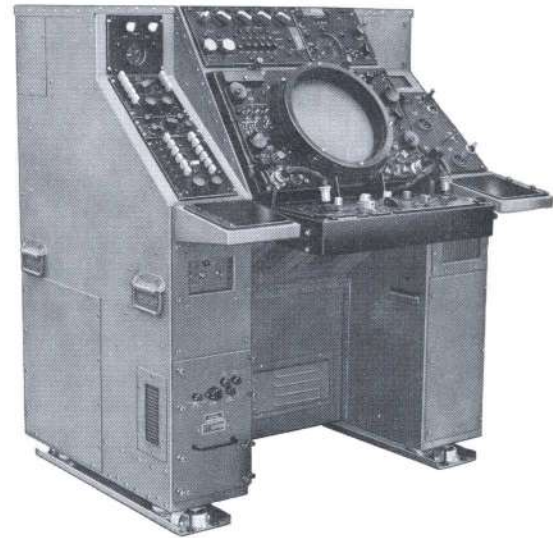
Dual Gun Display



AN/UPA-35, U.S. Air Force Universal PPI



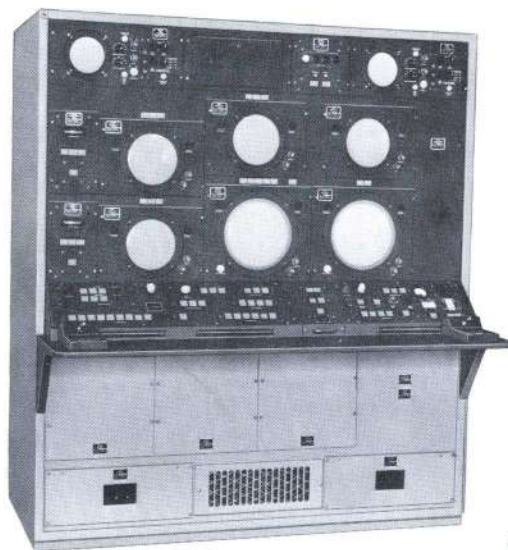
AN/APA-125, U.S. Navy and Air Force



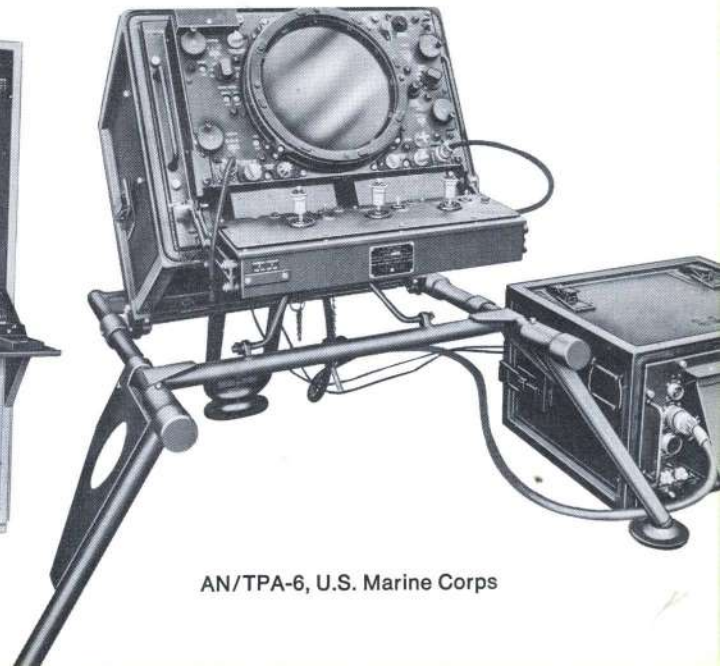
AN/APA-159, U.S. Air Force



AN/SPA-8A, U.S. Navy



AN/FPA-16, U.S. Army ECCM Console



AN/TPA-6, U.S. Marine Corps

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Hazeltine and the Pursuit of Excellence

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