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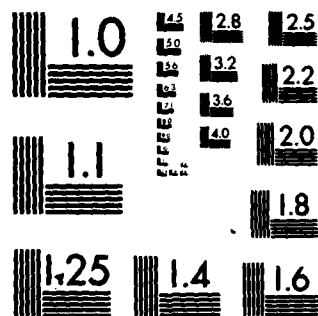
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The Defense Mapping Agency Hydrographic/Topographic Center (DMAHTC) is engaged in researching, planning, compiling, and constructing charts, digital graphics and data bases, and plotter-derived support products through the use of the Advanced Cartographic Production System (ACPS). This presentation highlights the cartographic products generated in support of the military and civil mapping requirements.		

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AUTOMATED CARTOGRAPHIC PRODUCTS

MARY CLAWSON

Cartographer
Defense Mapping Agency
Hydrographic/Topographic Center

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The Defense Mapping Agency Hydrographic/Topographic Center (DMAHTC) is engaged in researching, planning, compiling, and constructing charts, digital graphics and data bases, and plotter-derived support products through the use of the Advanced Cartographic Production System (ACPS). This presentation highlights the cartographic products generated in support of the military and civil mapping requirements.

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AUTOMATED CARTOGRAPHIC PRODUCTS

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INTRODUCTION

Beginning in the early 1960's the Defense Mapping Agency Hydrographic Center began developing automated techniques to apply to its cartographic production requirements. The various computer programs which were developed and the precision plotters which were used formed the basis of the Advanced Cartographic Production System. Through the increased sophistication of the software, recent advances in precision plotters, and the addition of the Linear Input System, the Defense Mapping Agency Hydrographic/Topographic Center can currently meet the most stringent requirements of many diverse cartographic applications.

This paper focuses on three types of cartographic production endeavors within the Center which use the Advanced Cartographic Production System (ACPS). These efforts are as follows:

- (1) The direct support to the nautical charting program of the Center.
- (2) The preparation of special maps and charts for use both within the Center and also in support of the wider military and civilian community.
- (3) An on-going program to improve all phases of map and chart production within the Center through the increased use of the Advanced Cartographic Production System.

THE USE OF AUTOMATION IN NAUTICAL CHART PRODUCTION

Direct support to the nautical charting program of the Center is one of the most important functions of the Advanced Cartographic Production System. Specifically, the system is responsible for creating chart projections, navigational rates, wreck plots, isogonic lines, manuscript transformations, and also complete chart compilations.

The Advanced Cartographic Production System produces the completed projection for all new nautical charts. Nautical charts are almost exclusively compiled on Mercator projections. The degrees, minutes, and seconds of latitude and longitude are shown on the chart in one of

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two methods depending on the scale of the chart. Charts at a scale of 1:75,000 and larger have a plan border (Figure 1), whereas smaller scale charts are shown on scale border projections (Figure 2). The plan border projection may be relatively simply or very complex and may include one or more chart insets. The placement of all of the projection border type, including that in the border scales and also on inset bar scales, is completely automated (Figure 1). When plotted with the photo head or CRT printhead on the Gerber* flatbed plotter, the final projection is ready to be printed as part of the base of the nautical chart.

Scale border projections required on all nautical charts at a scale smaller than 1:75,000 were once very costly because of the number of hours required to accomplish all of the border subdivisions and shading. Before automation, scale borders would take approximately 40 hours to compute, layout, and scribe. This time has been reduced to less than 1 hour of input time, approximately 20 seconds of CPU, and 1 hour on the photo plotter through the use of improved computer software.

Another element of most nautical charts is the electronic navigation overprint information. Begun in 1965 this was the first application of automated cartography in the Center. This information is portrayed as a series of lines, indicating the rate and lane value (Figure 3). The Advanced Cartographic Production System provides these rates as either a scribed negative or an annotated photo-plotted positive. Again, as in the case of finished projections, the savings in production time is enormous.

The Advanced Cartographic Production System also provides wreck plots and isogonic line plots for use on nautical charts. The wreck symbols are plotted automatically from a wreck data base. The isogonic lines are computed and plotted for the required geographic coverage of the nautical chart.

The plot tapes to produce all of the above mentioned nautical chart support products are generated via batch processing on a UNIVAC 1100/42. The computer input is a card deck in which the program selection and specific chart construction parameters are specified and used to create the plot tapes used to drive the plotters.

Another form of support for nautical chart production is derived through the Linear Input System (LIS). The LIS is an automated, computerized process using minicomputers, peripheral tape and disc units, printers, plotters, line digitizers, and display devices coupled with custom-developed computer software programs and cartographer/machine interaction. Figure 4 shows the hardware configuration of the LIS. The LIS work station is shown in Figure 5.

*Any mention of a commercial product does not constitute endorsement by the United States Government.

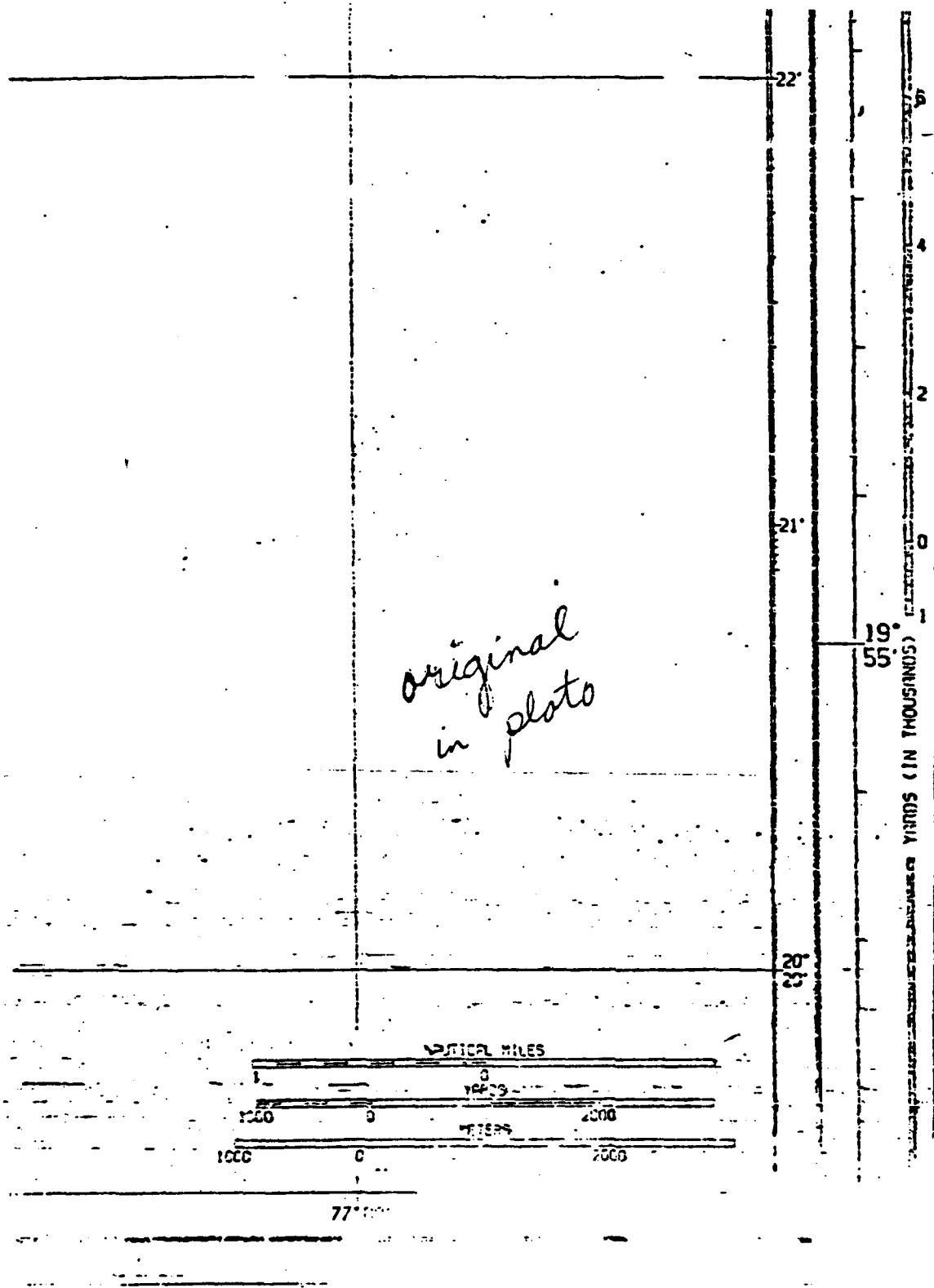


FIGURE 1. SECTION OF A PLAN BORDER WITH INSET BAR SCALES.

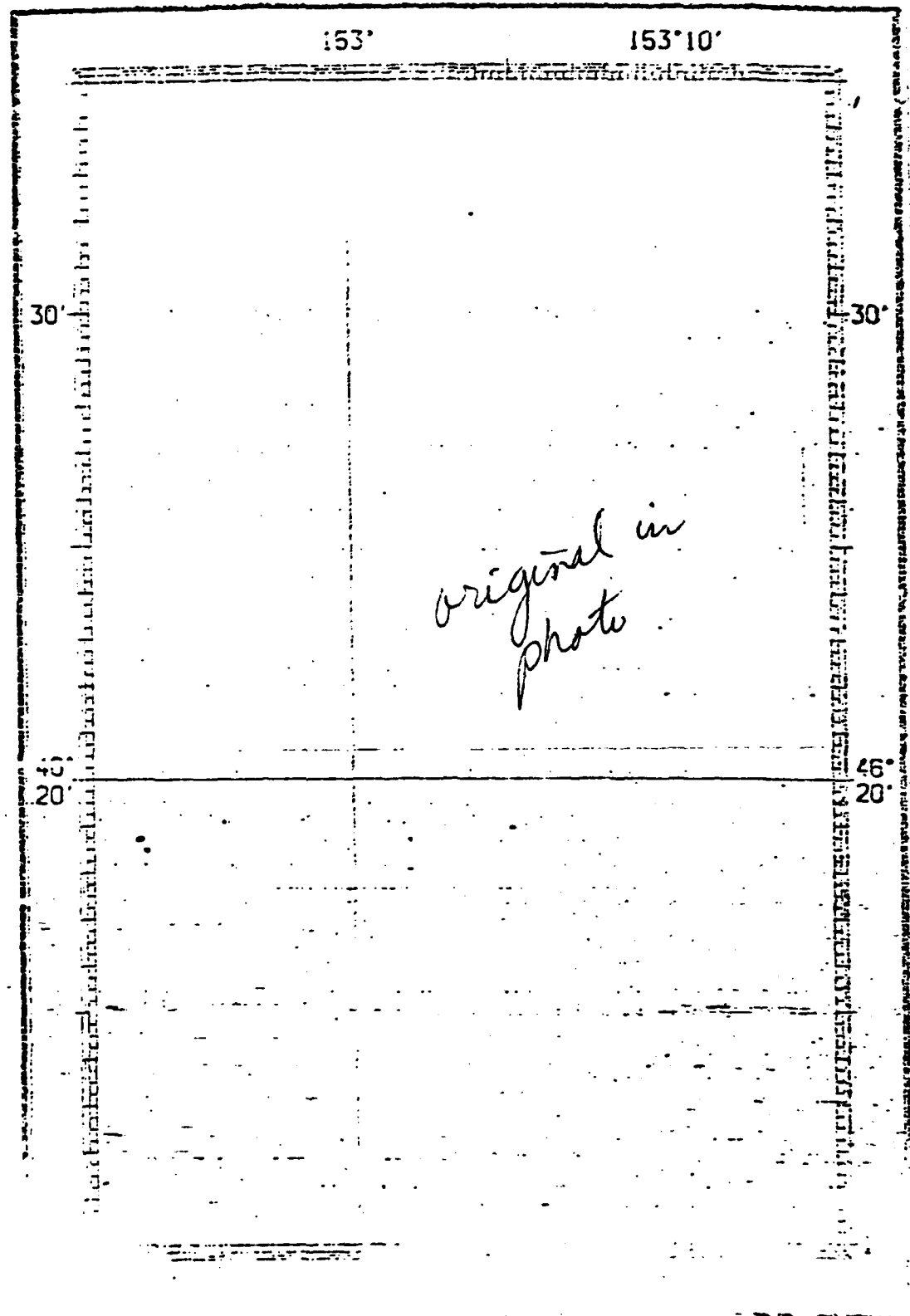


FIGURE 2. SCALE BORDER PROJECTION

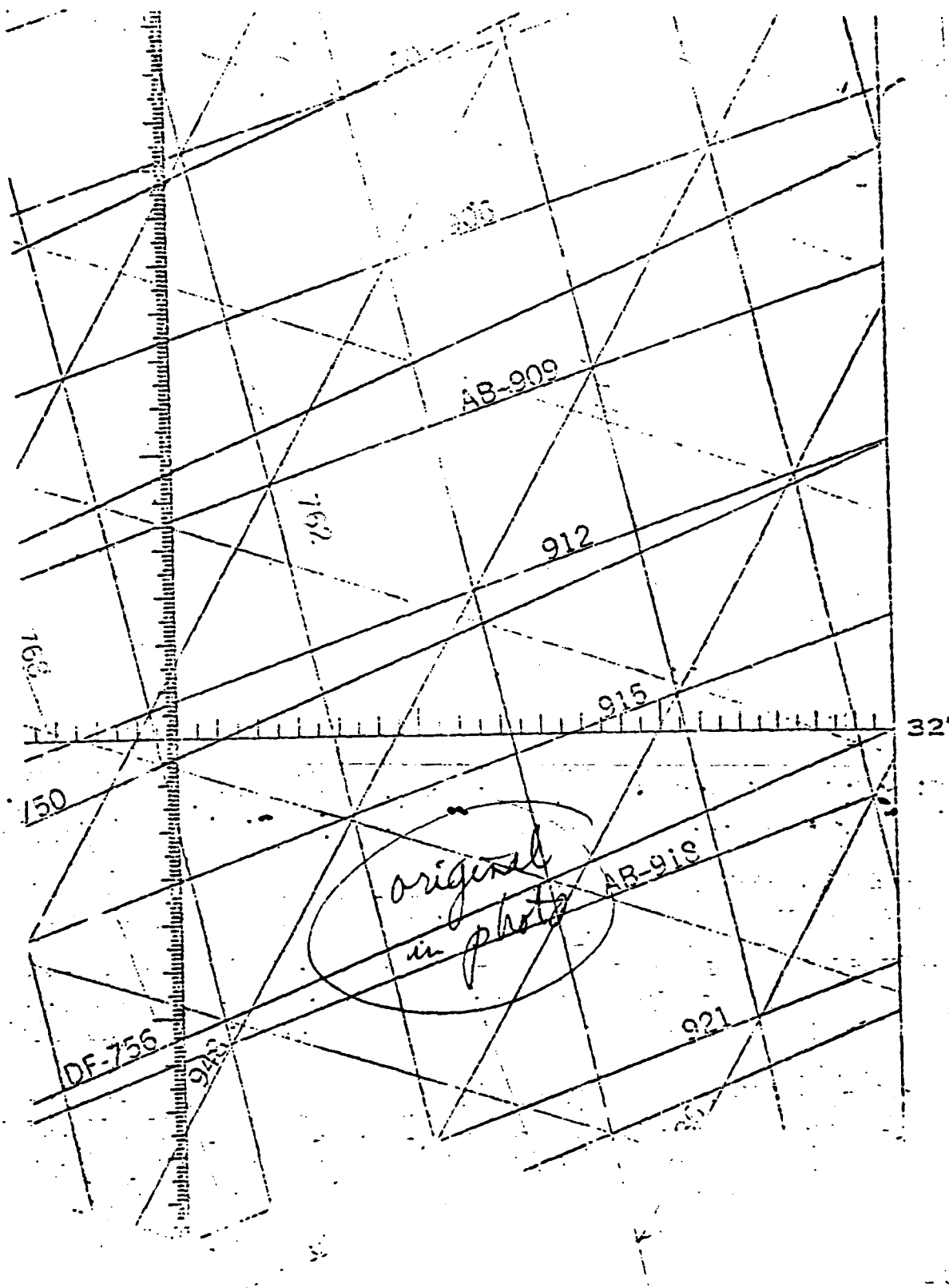


FIGURE 3. ELECTRONIC NAVIGATION OVERPRINT INFORMATION

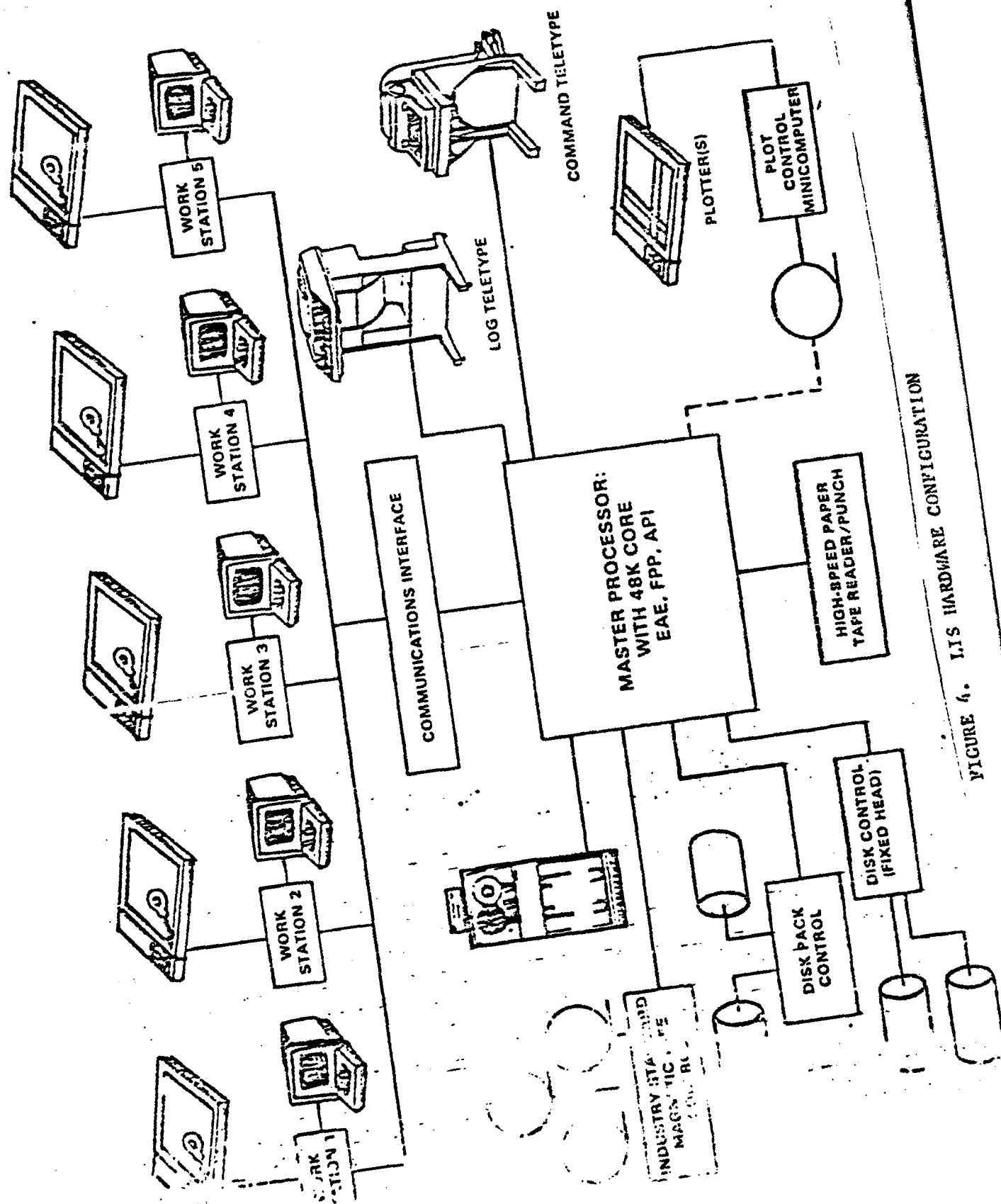


FIGURE 4. IIS HARDWARE CONFIGURATION

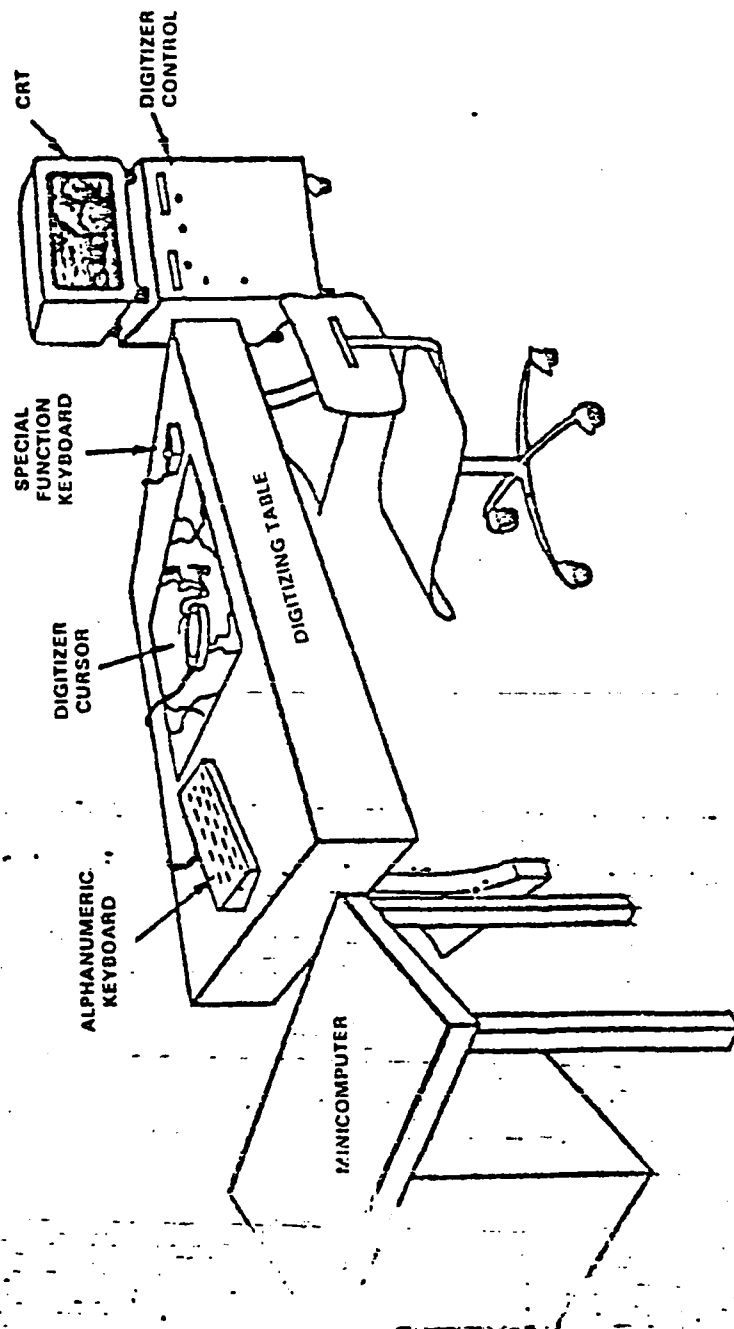


FIGURE 5. THE LIS WORK STATION

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The LIS has the capability to transform digitized geographic files in two ways. First, the geographic features may be digitized and plots generated for any of the following ten projections: Mercator, Transverse Mercator, Albers Equal Area, Gnomonic, Ployconic, Lambert Conic Conformal (2 standard parallels), Oblique Mercator, Polar Stereographic, Azimuthal Equidistant, and Azimuthal Equal Area. Second, scale changes may also be accomplished through the LIS.

These two options make many difficult cartographic problems relatively easy to solve. For example, to transfer information from a Lambert projection, at a scale of 1:500,000 to a Mercator projection at a scale of 1:1,000,000 would require approximately 40 hours to complete if you had to manually scale off and replot the required information. With the use of the LIS, it is possible to digitize the information from the Lambert projection manuscript and produce an output plot tape of the requested information on the Mercator projection at the new scale in approximately 20 hours. A plot of this tape would provide the final symbolized product.

In support of the nautical charting program, this capability is typically used to transform information from 1:25,000 Transverse Mercator topographic manuscripts to information on a Mercator projection at the selected scale for the chart to be printed.

The LIS has also been used in the complete compilation of nautical charts. In this case, all of the information to be shown on the chart is digitized from various source documents including topographic manuscripts, smooth sheets of the soundings, and other nautical charts. This digitized information when processed through the symbol plot software produces the plot tape commands to generate the necessary line types, symbols, and soundings required on each plate. When this output tape is plotted with the Gerber photo head, all of the color separated originals necessary for printing the chart are completed.

Whether it is the completion of just the finished projection, or the production of all of the color-separated plates for a nautical chart, the Advanced Cartographic Production System plays an important role in the nautical charting program at DMAHTC.

SPECIAL MAPS AND CHARTS

A wide variety of special maps and charts can be provided through the Advanced Cartographic Production System. The majority of these special products fall into two categories: (1) plotting sheets and (2) planning graphics. These special maps and charts are sometimes one-of-a-kind originals or may be printed charts of a limited edition.

Plotting sheets are often simply skeleton projections. Besides the familiar Mercator and Transverse Mercator projections, the ACPS offers 24 other possible projections. The projections available in the ACPS are the following:

- Albers Equal Area Conic
- Azimuthal Equal Area
- Azimuthal Equidistant
- Galls Stereographic
- Geographic Position to North Indonesian Grid
- Gnomonic
- Hammers
- Lambert Conic Conformal (2 standard parallels)
- Lambert Conic Conformal (1 standard parallel)
- Lambert Equal Area Cylindrical
- Lambert Equal Area Polar
- Mercator
- Mercator Sinusoidal
- Millers
- Modified Lambert Conformal for Polar Areas
- Mollweide
- Oblique Mercator
- Orthographic
- Polar Stereographic
- Polyconic
- Rectangular
- Skewed Orthomorphic
- Square
- Stereographic Equal Area
- Stereographic Projection of a Sphere
- Transverse Mercator

Plotting sheets are sometimes requested with other cartographic information which is also provided by the ACPS. The user may request a shoreline representation from World Data Bank I or II, range circles based on a geographic position whether on or off the sheet, azimuth lines, or a series of geographic positions which are plotted and annotated. Any or all of the cartographic representations can be plotted on any of the 26 available projections.

The software exists to generate any of these cartographic representations on the identified 26 projections at any scale and for any geographic coverage of the world. The only limiting factor is the size of the flatbed plotters (150 by 120 centimeters) which determines the maximum size of the original to be plotted.

These ACPS capabilities make it possible to provide a variety of quick response or crisis support graphics. The capability to provide special purpose plotting sheets or graphics in a short time frame is very important to the Center.

A request was made on April 2, 1979 to produce a series of 57 new plotting sheets by July 15, 1979. The user had the following requirements:

- (1) A scale of 1:3,000,000
- (2) Lambert Conic Conformal (2 standard parallels) projection
- (3) Portray shoreline, drainage and international boundaries
- (4) Show cities with a population over 200,000
- (5) Sheet size of 18 by 22 inches
- (6) Water tint
- (7) Print 1,100 copies of each sheet

The ACPS was used to produce the following originals for each map in the series:

1. Annotated projection base with shoreline and drainage from World Data Bank II (film positive from Gerber photo-head)
2. City plot from a data base compiled specifically for this requirement (film positive from Gerber photo-head)
3. Boundary guide from World Data Bank II (Xynetics ballpoint copy)

In all approximately 450 plot tapes were generated to produce the 228 plates needed to meet this requirement. Each sheet took a combined total of 27 hours of compilation, drafting, and editing time. It is estimated that to fulfill this requirement through manual methods would have taken 10 times as long. (Figure 6 shows a portion of one of these charts.) It might also be mentioned that all of the chart parameter input required to generate the plot tapes was made by one cartographer. The necessary water tint plate, boundary scribe plate, and border type stick-up was completed by one cartographic technician and one editor was responsible for checking the accuracy and completeness of the sheets.

This requirement would have been virtually impossible to complete in the short time frame without the ACPS. Clearly, the ACPS has the capability to greatly increase the Center's productivity and also make the Center responsive to the needs of the user in a timely fashion.

Planning graphics are rather similar to plotting sheets. The main difference is the portrayal of existing charts or map sheets as an index for a particular area of the world. These sheets are typically produced for in-house use and are not printed.

POSITION PLOTTING CHART

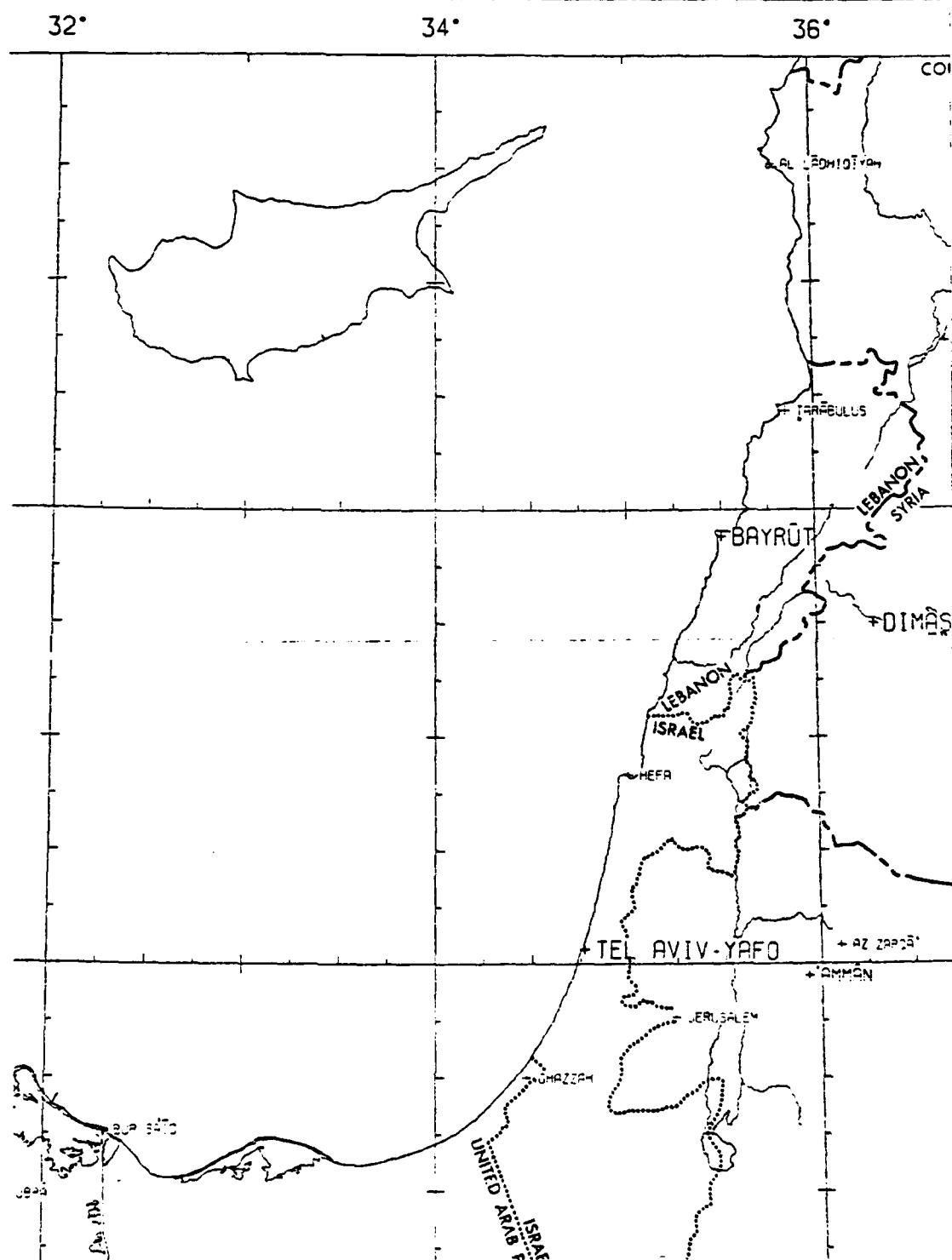


FIGURE 6. PORTION OF A POSITION PLOTTING CHART

The Center also receives requests to provide special maps to other Federal agencies, universities, and private mapping firms. Most of these requests are for a projection with a shoreline from either World Data Bank I or II. Figure 7 is an azimuthal equidistant projection of the world centered on Portland, Oregon. This map was prepared for the University of Oregon.

Although these special maps and charts often make up a sizeable portion of the work completed by the ACPS, these products tend to be less visible to the user community. Even so, their importance should not be overlooked.

FUTURE APPLICATIONS OF THE ADVANCED CARTOGRAPHIC PRODUCTS SYSTEM

The Advanced Cartographic Production System is constantly undergoing revisions and enhancements to increase the sophistication of its software and hardware.

Recent software enhancements include the following:

1. Index program
2. Azimuth line annotation
3. State Plane Coordinate Grid
4. City Plot Capability

The additions to the hardware configuration of the ACPS are the following:

1. CRT print head for the Gerber plotter
2. Sci-Tex Response 250 Mapping System
3. Hamilton Standard color raster scanner

The CRT print head for the Gerber flatbed plotter will significantly increase the capabilities of the ACPS. The reasons for this fact are twofold. First, the CRT print head will reduce the time required to produce a final photo plotted original by as much as 60 percent. Second, the font, text, and symbol libraries which are included with the CRT print head will enable the cartographer to place most of the standard border type directly on the projection base.

The Sci-Tex Response 250 Mapping System is a color raster system. It was acquired by DMAHTC to facilitate the production of Modified Facsimile Charts. It is expected that when put into production, the Sci-Tex will significantly reduce the time required to produce the modified, color separated reproducibles necessary for the production of modified facsimile charts.

FIGURE 7. AZIMUTHAL EQUIDISTANT PROJECTION CENTERED IN PORTLAND, OREGON

The Hamilton Standard color raster scanner will interface with the Sci-Tex for additional raster chart production capabilities.

The additional capabilities of the Advanced Cartographic Products System will improve all phases of map and chart production within the Center. There is a continuing effort to expand utilization of the ACPS for increased productivity.