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CHART MODIFICATION AND REPRODUCTION WITH A RASTER SYSTEM.(U)
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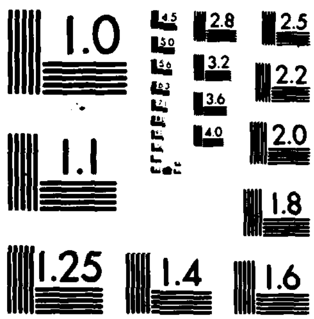

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The Defense Mapping Agency Hydrographic/Topographic Center (DMAHTC) acquired the SCI-TEX Response 250 Mapping System (R250/MS) to facilitate the production of modified facsimile charts. Currently, a preliminary evaluation indicates that the system is capable of producing the modified color-separated reproducibles required for the production of modified facsimile charts. Editing of a raster file remains the most time-consuming phase of the production flow. Standard operating procedures to reduce edit time and scanning procedures to reduce the amount of spurious data are currently being established.

20. Continued

The addition of font, symbol, and text libraries will further increase the capabilities of the R250/MS.

Following the establishment of the system in the modified facsimile reproduction process, other avenues of cartographic applications will be explored.

CHART MODIFICATION AND REPRODUCTION WITH A RASTER SYSTEM

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ABSTRACT

A SCI-TEX Response 250 Mapping System was acquired by the Defense Mapping Agency Hydrographic/Topographic Center (DMAHTC) to facilitate the modification and subsequent reproduction of foreign charts and other cartographic source materials. The Center is currently evaluating the system's capabilities for cartographic applications.

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WITH A RASTER SYSTEM

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INTRODUCTION

The Defense Mapping Agency Hydrographic/Topographic Center (DMAHTC) performs a significant portion of the military mapping, hydrographic charting and geodetic support activities for the Department of Defense. In addition to providing charting support to the Navy, DMAHTC has a statutory responsibility according to title 10 of the U. S. Code, to provide "accurate and inexpensive nautical charts, sailing directions, books on navigation, . . . for the use of all maritime nations, generally". Foreign chart modification and reproduction is one of the many support activities with which DMAHTC fulfills these responsibilities.

In accordance with exchange agreements negotiated between DMAHTC and various hydrographic chart producing countries, a multitude of hydrographic chart and chart-related products are routinely exchanged for foreign maps, charts, and other pertinent information. These agreements permit DMAHTC to produce facsimile reproductions of nautical charts received from these various participating countries. Of paramount importance to DMAHTC is having the capability to rapidly reproduce and distribute those foreign chart products with latest changes. These changes include the positional shifting of navigational hazards, such as submerged reefs and sea mounts. In addition, place names, border information and symbology are often replaced to reflect Defense Mapping Agency (DMA) and International Hydrographic Bureau (IHB) standards.

For a foreign chart to be recast in a DMA format, updated, and then reprinted (as a modified facsimile) color separations (reproducibles) are needed. A color separation contains all of the information represented by one color of a source document. These reproducibles are used to create plates from which charts are printed. For each color to be reproduced, a color separation film positive or negative must be acquired or generated. Charts produced at DMAHTC via modified and direct facsimile means are dependent upon the availability of reproducibles provided by those foreign countries with which bilateral agreements have been negotiated. In obtaining these reproducibles, a 6-to 8-month, or longer, period may evolve before they are received by DMAHTC. At this juncture, manual production procedures are employed to modify or change that information (symbology, border, text, etc.) necessary to satisfy DMA format/content requirements. By the time a foreign chart has been modified and reprinted, a 10-to 12-month period will have often elapsed.

NOTE: The opinions herein are the author's and do not represent the opinion of the U. S. Government.

There are then several problems which exist under current procedures for the production of modified facsimile charts: 1) The availability of the reproducibiles, 2) the time needed to procure reproducibles and 3), the additional time needed to modify these reproducibles after procurement.

If the need for acquiring reproducibles is eliminated, and the time necessary for modification reduced, a more efficient modified facsimile chart production process can be established. To realize this goal, the Automated Raster Cartographic System (ARCS) was developed and, as a subsystem to ARCS, the Response 250 Mapping System (R250/MS)* was purchased.

The R250/MS equipment configuration (Figure 1) as purchased by DMAHTC, consists of a Raster Scanner, two Raster Edit Stations and a Laser Plotter (camera).

The Raster Scanner is a high-speed drum scanner, operating at 130 revolutions per minute. It is capable of scanning transparent or opaque single or multi-color source documents. The source document is mounted on the rotating drum and data are "sensed" or recorded via the optical scanning head mounted above the drum surface. The scanner can sense up to 12 colors per scan, and accommodates source documents up to 36 inches in length by 36 inches in width.[1]

The R250/MS Edit Station is an interactive color raster Edit Station consisting of a 19-inch color display console (CDC), and electronic tablet (digitizer) with a stylus for cursor control, special function keyboard (SFK), a Cathode Ray Table (CRT) command console, and a teletype. The edit station is capable of displaying a 12-color raster file, with each color assigned to a separate color channel. The edit station is the primary vehicle for raster file modification and editing.[2]

The Laser Plotter of the R250/MS is a variable resolution film exposure unit that produces color separation film positives or negatives. This outputting unit is capable of accommodating film up to 42 inches in width by 75 inches in length.[3]

At this time, the DMAHTC is in the process of evaluating the capabilities of the system to meet the goal of an efficient modified facsimile reproduction process, as well as establishing standard operating procedures, and production standards.

There are two capabilities which a system must possess if it is to produce modified facsimiles. First and foremost, it must be able to produce color separation film positives or negatives from the paper copy of a given chart. This capability will eliminate the need for obtaining reproducibles from foreign countries. Secondly, the system must possess some capability in which the data (used to generate color separated film positives or negatives) can be modified prior to the actual production of the separations.

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

FUNCTIONAL DIAGRAM

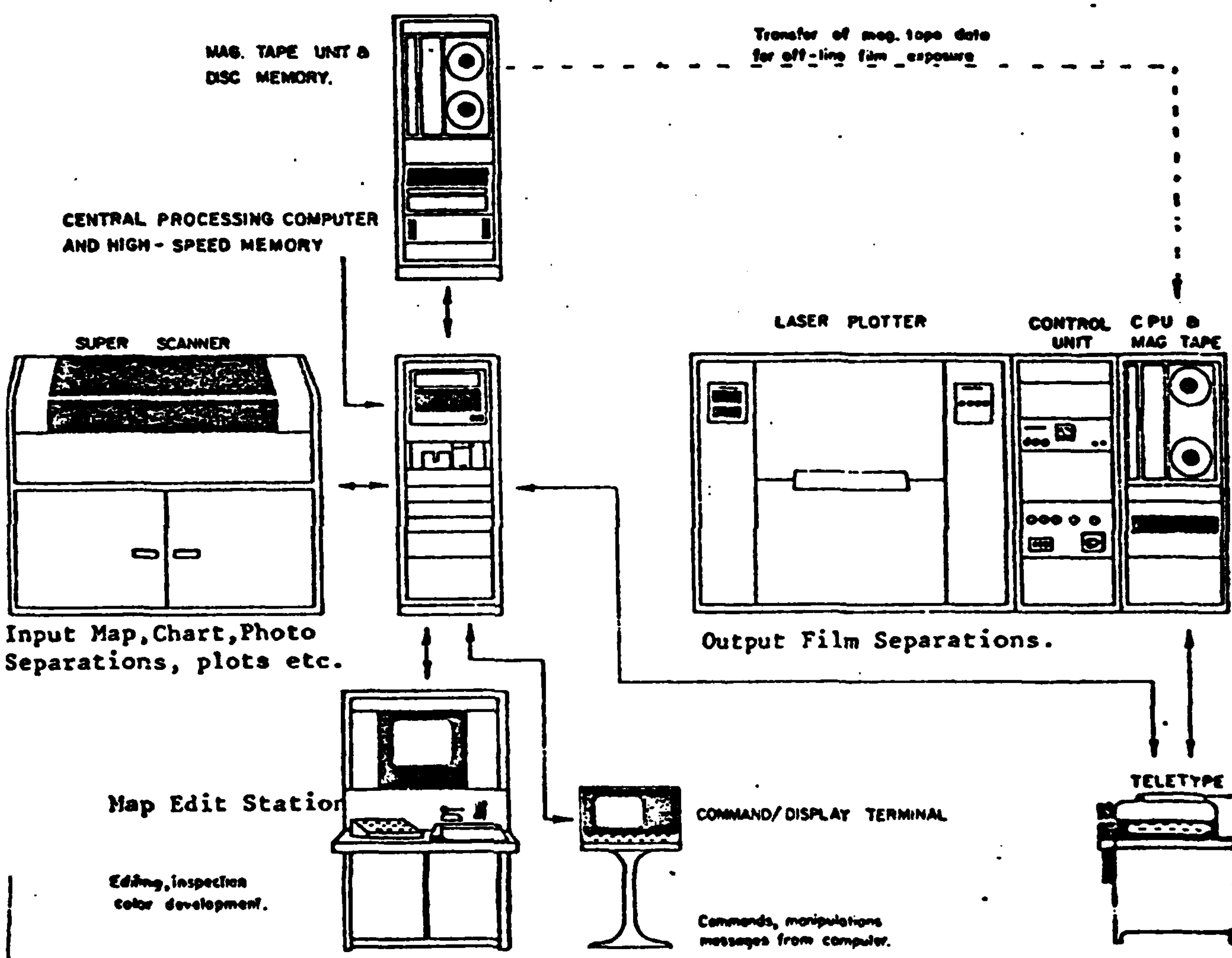

Figure 1.

THIS FUNCTIONAL DIAGRAM OF THE R-250/MS DEPICTS ORGANIZATION, OPERATION AND INTERFACE.

("Cartographic Digital Image Processing and Production System", Sci-Tex Corporation Limited, p.4.)

The R250/MS meets the above requirements through the use of the Raster Scanner, Raster Edit Station and Laser Plotter.

The Raster Scanner senses the information present on a chart and records the position of that data as a function of an x-and y-coordinate position in an array. These data points are recorded based on only one characteristic - color. This information is then transferred to the edit station where it is displayed in a raster format on the CDC. The raster file at this juncture is modified and edited through the utilization of the edit stations capabilities. Following this editing and updating of a foreign chart to DMA format requirements, separation files are generated - a unique file for each color to be separated. These files are used to drive the laser plotter, the film exposure unit, thereby generating the color separated film reproducibles needed for the reprinting of the chart.

This production flow through which color separated reproducibles are generated in modified form from a paper chart, consists of four phases: chart analysis and scanning, editing, modification, and color separation.

Of these four phases, the editing of erroneously coded data (spurious data) is, by far, the most time consuming. The minimization of the generation of spurious data (and thus, the time required for editing) is, therefore, of paramount importance to the production process.

CHART ANALYSIS AND SCANNING

Upon receipt of a chart or map for color separation, the cartographer must examine the chart in terms of the scanner's operation. During this analysis phase, the cartographer must also determine the best scanning procedure in light of the desired form of the final product. A clearer understanding of these considerations can be realized through a discussion of the scanning process.

Basically, the scanner is the vehicle through which map or chart data are sensed and recorded in a raster formatted mode. Its function is analogous to that of the human eye, in that the raster scanner, like the human eye, receives data from an external environment and interprets that data as a function of some internal set of constructs. It should be noted, however, that the raster scanner can only sense one pixel (point) of information at a time, and that this pixel is interpreted as a function of only one characteristic - color.

As a consequence of this method of data interpretation, two scanning characteristics should be pointed out. The human eye views the agglomeration of a color or colors on a chart or map to be of a certain shape, and this shape is, in turn, interpreted to be cartographically significant (a nautical symbol, a contour line, etc.). The scanner will interpret this same information as many different pixels of information which are assigned an appropriate color code. There is no character recognition as each pixel of information is interpreted independently.

The human eye also has the ability to blend very small points of various colors into one seemingly different solid color. The scanner, for the most part, does not do this. If, on a hypothetical chart or map, there are five shades of red (to the human eye), and these shades were created by varying the ratio of red points of color to white points, when scanned, this chart or map will have only two colors sensed and recorded - red and white. What appears to be five shades to the untrained eye, will be recorded as two colors by the scanner.

The cartographer, when examining a chart or map, must determine the number of colors which the scanner will record, not what the human eye perceives. In addition, when analyzing a chart for scanning, the cartographer must take into account the complexity of detail associated with the source document. Two factors which must be considered when examining a chart in this context are resolution and spot size.

Resolution is defined as the number of points which will be recorded per millimeter by the scanner. Usually, spot size is set according to a previously determined correlation to resolution. Special circumstances might dictate a larger or smaller spot size than is recommended by this correlation. Spot size will determine the size of the area sensed for any given pixel of information. Thus, resolution defines the center of a pixel and spot size determines the area to be sensed. Logically, the more points of data sensed per millimeter, the better defined the information will be when recorded in a raster file. This, in turn, will lead to color reproducibles of a higher quality. If a chart or map contains many fine details, more points of data must be recorded for proper representation in the raster file. Conversly, a coarser resolution is used when chart data is not that fine.

Data being sensed during the scanning process must in some way be color coded. There must be some way in which a color designation is attached to a pixel of information. The method through which this is accomplished with the Sci-Tex is color and high-voltage calibration.

High-voltage calibration establishes the maximum saturation (reflectance) level of three primary scan colors (red, green and blue). It must always be calibrated over white or the background area of the chart or map to be scanned.

Color calibration establishes an internal reference table of reflectance values for those colors which are to be scanned. These values are represented in this reference table as a percentage of reflectance of the three primary scan colors.[4]

In establishing these values, several "sensings" of a color are taken in various areas of the chart to arrive at an averaged reflectance value for that color. Each color, when calibrated, is assigned a color channel. The reflectance value for that color is associated with that channel. When a pixel of information is being sensed during scanning, its reflectance value is compared to those in the reference table. The color channel of that value in the reference table which most closely matches the sensed data is assigned to the sensed data. All information on a chart or map is color coded in this manner.

SCANNING AND SPURIOUS DATA GENERATION

In theory, if a chart is properly analyzed and color calibrated, the raster file generated from a scan of this chart should need no editing, (the edit operations are concerned with the elimination of scanner originated erroneously color coded data). Modification of this raster file and subsequent color separation should not be hindered by the presence of spurious data (erroneously color-coded pixels of data). Such an occurrence could only come about for a multi-color scan if two conditions are met: the printed quality of the source document is such that all color hues are of even intensity across the entire chart, and that all pixels of information, when sensed, contain only one color. It is unlikely, however, that these conditions can be met. Their significance in the generation of spurious data can be understood through a discussion of color calibration.

For any given scan, as the number of colors calibrated increases, so does the similarity or closeness of their reference table values. This has the effect of narrowing the range into which the reflectance characteristics for a given color must fall in order for that information to be properly color-coded. Thus, for a pixel of information to be properly color-coded, its value must approach the reference table value within a smaller tolerance. It must be remembered that sensed data are compared to the calibrated values in the reference table and color-coded on the basis of the best possible match to one of these values. If a chart is of poor printed quality, there will be a considerable amount of variation in intensity for a given color. These tonal variations will cause some data to be erroneously color coded, thereby generating spurious data. The extreme hues in the range of hues of a given color are the problem areas.

There is another scanning characteristic which lends itself to the generation of spurious data. When sensing two colors simultaneously (i.e., when a pixel of information contains two colors, such as in a color transition area of a chart or map) the scanner will average their reflectance characteristics to produce a value. This value then will not truly represent the reflectance characteristics of either one of the two original colors. For this reason, when it is compared to the values in the reference table for color coding, it has a high probability of being assigned an erroneous code of a third color. When a raster file containing this type of spurious data is viewed on the color display console (CDC) of an edit station, the improperly coded data will appear as halos or frames around properly coded features.

One more problem must be pointed out in regard to scanning and spurious data generation. Most paper copy charts are created by printing each color of the proposed chart on the same base. This method of printing will inevitably lead to the creation of areas on a chart where information represented by one color overprints information represented by a second color. For this data to be properly represented in the reproducible of each color, the area must be calibrated separately. If it is not, one or both reproducibles will contain discontinuous information where they overlap. This is due to the fact that overprint areas can have different reflectance characteristics than either of the basic colors.

The solution to this problem is to calibrate these areas as independent colors. When color reproducibles are generated for the two basic colors, the overprint data are included with each. This will insure that the data on both plates is uninterrupted. There is, however, a drawback to this solution - the possible generation of spurious data.

If an overprint area reflectance characteristic is very close to that of another color, the calibration of this area might cause extreme values in the normal range of that color to be coded improperly, i.e., they will be coded as the overprint color. In other words, this will have the effect of truncating the extreme values from the range of values normally coded as that color.

The question confronting the cartographer now is, short of scanning an entire chart, how can he tell how much spurious data will be generated for a given set of color calibrations? The answer to this question is imperative if a quick-response time is to be realized in modified facsimile production.

It must be remembered that the editing of spurious data is the most time consuming phase in the production process. Since the degree to which spurious data is generated is determined by the quality of the color calibration, its refinement is most important.

A method through which a set of color calibrations can be examined, and spurious data generation minimized, is currently being investigated. It involves the use of test strips and manual color calibrations. Once the colors of a given chart have been calibrated, the cartographer selects a small representative strip of the chart to be scanned. This test strip should contain all the colors calibrated (including overprint colors).

Following the scan of this area, the resulting data are viewed by the cartographer via the CDC of the edit station. An examination of those areas more susceptible to spurious data generation, such as the edges of features (color transition areas) and areas of poor printing quality should reveal the extent to which these erroneous data have been generated. If it is felt that excessive spurious data have been generated, the cartographer can recalibrate the colors again or attempt a manual calibration.

Values in the reference table are represented as percentages of three primary scan colors: Red, Green, and Blue. Each reference value will therefore, be represented as a percentage of Red, Green, and Blue. By manually manipulating these percentages for a given reference value (inputting new, slightly different values than the original calibration values), the cartographer attempts to lend clearer definition with regard to what will be coded as a specific color. By narrowing the range of one reference value and expanding that of another, the generation of spurious data can be reduced.

All color calibrations will lead to spurious data generation. Test strips and manual calibrations are utilized only in the hope of minimizing such generation. Spurious data can never be totally eliminated from the scanner-generated raster file via these methods. The spurious data remaining in the raster file are eliminated through the use of edit station capabilities.

EDITING

If a color separated reproducible of a specific color were plotted from an unedited raster file, the resulting negative or positive would contain, in addition to valid data, discontinuous points, halos, and frames of spurious data. These spurious data were erroneously color coded during scanning and, if properly coded, would have been part of the valid data appearing on the reproducible of another color. Thus, if this reproducible were used to generate a plate which is, in turn, utilized in the reprinting of this chart or map, these areas of data would be printed in the wrong color, misrepresenting data on this chart or map. The purpose of editing then is to remove spurious data through the proper recoding of its color.

Spurious data, when viewed within the context of the total raster file, will more often than not, fall into two categories. The first type appears as islands of miscoded data in the midst of correctly coded color. These areas are usually several points in area, but can vary greatly in size. The second class of spurious data collects around the border of valid features (as frames and halos).

There are two types of edit operations to remove (recode) spurious data from a raster file. These are manual operations and automatic operations. The basic difference between the two lies in the amount of cartographic interaction necessary for their use. In addition, the manner in which the cartographer views or analyzes the spurious data will be different depending on which method is being utilized for the various areas of a raster file.

Manual operations require the cartographer to alter the appropriate color codes in the raster file to achieve the elimination of spurious data. These alterations consist of actually changing the color coding of erroneous data to its true value, pixel by pixel, or by defining the limits of an area within which the system will change all information to a specified color. Because of system imposed limitations, manual edits are generally not applied to the entire raster file, but only to small segments of that file. Manual edit functions are initiated via the special functions keyboard.

When the cartographer utilizes manual edit functions, he will not generally view spurious data within the context of the entire file, but rather only as a function of that small segment of the file which is to be manually edited. The distribution of spurious data within the entire file is only analyzed to determine the areas of the chart which must be edited.

When automatic edits are used, however, they are applied to much larger areas, if not the entire raster file. These edits are faster and require less cartographic interaction with the system. Automatic edits allow the cartographer to eliminate data throughout the whole file, or a large segment thereof, without working on a pixel or small segment basis. Automated edits are, therefore, more suitable for large edit areas. Because of this, it is necessary to view the spurious data within the context of the whole file, not just a small segment of it. The cartographer must analyze the classes of spurious data present in preparation for choosing the appropriate automatic edit function. Additionally, the relationship of the spurious data to all colors in the file and to the file as a whole must be considered. While some of these considerations must be examined for manual editing, they must be viewed in a much larger, more interdependent context when utilizing automatic edits. All automatic edit functions are actuated from the CRT command console.

The device through which the raster file can be accessed and displayed is the Raster Edit Station. Manual edits are initiated via the Special Functions Keyboard of the Edit Station and Automatic Edits via the CRT command console. An understanding of the edit stations' capability to access and display raster segments is essential, if editing in general is to be understood.

DATA ACCESS AND DISPLAY

During scanning, each pixel of information is as described, interpreted as a function of only one characteristic - color. As sensed, the pixels are transferred to on-line disk storage.

The manner in which this file is formatted during scanning results in the creation of a coordinate system through which the cartographer can access and display raster file segments via the Edit Station. This formatting of the file is a product of two factors: 1) the raster (line by line) collection of data; and 2) the resolution selected.

When a chart is scanned, it is mounted on the rotating drum of the scanner, and as the optical scanning head passes over an area, data are sensed. The selected resolution, not only determines the points per millimeter (PPM) to be sensed, but in doing so, also commands the scanner head to stop and scan a line of data or a precise number of times within a millimeter. In essence then, when this resolution is selected, the following two things are determined: 1) the number of lines to be scanned per millimeter, and 2) the number of points within each line to be sensed. Since only one resolution parameter is selected during a scan, it necessarily follows that the number of scan lines per millimeter within a given line. Thus, the file will be composed of rows and columns of pixels whose centers are equidistant from one another. In actuality, what is created during a scan is a rectangular array of color coded pixels, each pixel with a known location expressed as an x- and y-coordinate position. The coordinate value x being the number of the scan line in which the pixel was sensed (the R250/MS refers to this value as "height"). The y-value is the position of that pixel within the scan line (the y-value is referred to as "width" by the system). These x- and y-values are interpreted as the position of a pixel relative to the first pixel ~~relative to the first pixel~~ in the first line scanned, and are expressed as points (P) of height (x-value) and width (y-value). Thus, a value of 80P in height and 50P in width refers to the 50th pixel sensed in the 80th line scanned.

This coordinate system allows the cartographer to define a point in the raster file, and through its location, access a raster segment for display. (The system command which accesses data for display is named "color.") The raster segment accessed will be composed of pixels of information which fall below and to the right of the defined point in the file. That is, a coordinate value is used as input with the "color" command. This point will be displayed in the upper left hand corner of the CDC, and the entire displayed image will be composed of points of information which fall below and to the right of this point in the raster file. The number of pixels accessed for the entire display (i.e., the size of the raster segment displayed) will be dependent upon the degree of image enlargement or reduction (called "zoom" by the R250/MS) requested with the color command.*

The CDC of the edit station utilizes "color display elements" to present the image of a raster file on the screen. The number of these elements available for display is fixed at 320 elements in width by 240 elements in height (a frame). If the cartographer, when utilizing the "color" command, does not specify a zoom, the system will default to a state of no image enlargement or reduction. That is, the raster segment accessed will contain 320 pixels in width by 240 pixels in height, creating a 1:1 ratio of color display elements to raster pixels. This state is referred to a "zoom + 1".

A zoom of +1 is equal to an area of 6 mm by 8 mm on a chart scanned at 40 resolution. Since most charts will be greater than 750 mm by 750 mm in length and width (30 inches by 30 inches), a cartographer would have to review approximately 11730 frames (a considerable undertaking in both time and effort) to cover the entire raster file. To alleviate this condition, the system provides for negative

*It should not be misconstrued that each individual pixel is stored independently. Data are "run length encoded". That is, adjacent pixels which are coded the same are stored together. The form of this storage would appear like this: Blue - 6. In other words, there are six pixels of blue. This cuts down considerably on the storage capacity needed, while not affecting the coordinate system at all.

zooms or image reduction displays. These negative zooms enable a larger segment of the raster segment to be displayed (thus a larger area of the chart) on the CDC. There is, however, one drawback in its use.

A zoom of -2, while it will double the area of the chart which can be displayed, (relative to zoom +1) will also cause a deterioration in the detail of the displayed image. When accessing this larger (zoom -2) area of the raster file for display, a greater number of pixels are called up. Since the number of color display elements is fixed, to view a raster file segment containing a greater number of pixels than this fixed amount, the system will filter out pixels of data to arrive at a generalization of the image which would be present at a zoom +1. As the image reduction approaches zoom -5, the displayed image will appear rather ragged in appearance.

The R250/MS also provides for image enlargement. A zoom +2 will halve the area of the raster file displayed (relative to zoom +1) and cause the representation of one raster file pixel by two color display elements. It should not be misconstrued that a zoom +2 will display greater detail than zoom +1. This will only have the effect of presenting in an enlarged state, the full detail present in a zoom +1.

This concept of full detail display (zoom +1 and greater) is important to the understanding of manual edit functions. There is a system-imposed limitation on two of these functions which relegates their use to a zoom +2. Thus, at a minimum, a one-raster pixel to one-color display element must be in force to use these functions. As demonstrated earlier, the area covered in such a zoom condition is very small indeed.

RASTER FILE REVIEW MANUAL EDITING

The "color" command, in addition to accessing and displaying a raster file segment, also transfers control from the CRT command console (from which the color command is actuated) to the special functions keyboard. This device, in turn, maintains control over the edit station.

The edit station, as stated earlier, is composed of the CDC, the SFK, the CRT command console, and an electronic pen and tablet. This pen and tablet serve as the mechanism through which spurious data are defined and eliminated. The pen and tablet are interfaced with the CDC and Edit Station in such a manner that as the pen is moved over the surface of the tablet, a corresponding point of color (the pen or cursor color) moves through the raster segment displayed on the CDC.

When the cartographer comes across a raster file segment which contains spurious data, he can, through the use of the tablet and pen (cursor) and the "Draw" function, recode these data. By selecting the "Draw" function (via the SFK) and a replacement color, the cartographer can move his cursor through the areas of spurious data. In doing so, each pixel contacted by the cursor color is changed to the selected replacement color. In this manner, spurious data are eliminated from this frame.

The cartographer, in utilizing the draw function, must actually scrub the frame of spurious data. This is time consuming and is exacerbated by the fact that this function is one of the two which must be utilized in a zoom +1. Because of this restriction, a need is created for the ability to access and display in a systematic manner the various segments of a raster file at zoom +1, via the SFK. In addition to this, there is a general need for the ability to access and display raster segments at any zoom for review and edit while the edit station is under the control of the SFK. The R250/MS provides two such methods for systematic display of the raster file which are actuated via the SFK (next frame and the move command group).

The next frame command, when initiated, allows the cartographer to view the raster segment, which is immediately adjacent to and to the right of (along the x-axis or height dimension of the file) that image which is currently displayed. The cartographer, by actuating this command several times, can view a series of raster segments in any zoom. Once a strip of the file is completed (the maximum width dimension is encountered), the next frame command will drop down to the beginning of the next strip immediately. In this manner, the file can be systematically reviewed, left to right, top to bottom.

If, during the course of next frame, viewing and editing, the cartographer wishes to review a previous frame, strip or any raster file segment, the move command group (move up, move down, move left, move right) can be utilized. The use of any of these commands will cause the Edit Station to display the appropriate raster segment as defined by the command chosen. Additionally, the use of zoom up and zoom down commands will cause the image displayed to be enlarged or reduced. The utilization of the move and zoom commands will not affect the next frame sequence as the system will remember and return to the "next frame".

If, while reviewing the raster file, the cartographer is presented, within a particular frame, with a mixture of valid data (of one color) and spurious data (of a different color), he can eliminate the spurious data through the draw function. If, however, in removing these spurious data, he accidentally passes over some valid data with his cursor color, it, too, will be recoded as the selected color. To prevent such an occurrence, the cartographer can "protect" the valid data by entering the "protect mode" via the SFK. This capability allows the cartographer to move his cursor anywhere within the displayed segment without affecting the colors designated as "protected".

In addition to the protect option, there are other edit aids which when used in conjunction with"draw" and other manual edit functions, facilitates the removal of spurious data. The width of the area affected (recoded) by the cursor in the editing of spurious data can be varied anywhere from 1 to 9 PPM. The choice of line width will depend upon the distribution of the spurious data within a frame (i.e., if the spurious data appears in close proximity to valid data of the same color, a small cursor area would be dictated).

If the cartographer views a frame in which there is spurious data whose color is very similar to but different from a valid color, distinguishing between the two can present a problem. There are two methods through which the cartographer can enhance his "visual acuity" with respect to spurious data. There are located on the CDC, 12 toggle switches, each of which is connected to one color channel. They can be used to suppress or turn on any one, or combination, of the twelve colors present in the display on the CDC. The cartographer can, in the situation outlined above, protect and then turn off the valid color which is similar in appearance to the spurious data color. In doing so, the visual location of spurious data in the pattern is facilitated. In addition to this method, there is another mechanism which can be utilized to enhance the differentiation of spurious data from valid data which is similar in color. The cartographer through the use of an edit station capability can change the color of a specific color channel. The edit station contains a manual color adjustment mechanism which makes it possible to vary the ratio of red, green and blue components of a color. By selecting a color channel and entering the manual color adjustment mode, via the SFK, the cartographer can change the color of that channel. Through the use of the capability, he can differentiate between the two close colors.

There are several additional manual edit functions controlled by the SFK which are useful on the elimination of spurious data.

The cartographer, when viewing several frames of spurious data, need not use the "draw" edit function to eliminate the data in each frame. Instead, the limits of the distribution of the spurious data can be defined and the rectangle function utilized to convert all data within a rectangle to a specified color. The region of action for the rectangle function is defined by placing into the raster file (via the pen and tablet) two points of color. These points of color will define the upper left and lower right corners of a rectangle within which the system will convert all data to a specified color. This command can be utilized at any zoom, but it should be pointed out that the "protection" of colors is not possible with this command. For this reason, no valid data should appear within the rectangle unless, of course, it is wished to eliminate such data. This restriction limits to some degree the size of the area to which the function should be applied.

AUTOMATIC EDITS

As stated earlier, the use of Automatic edits necessitates a different type of spurious data analysis.

From the discussion concerning manual edits, it is realized that, in most cases, their use, due to a lack of versatility or system imposed limitation, is usually restricted to small areas of the file. For this reason, the spurious data need not be analyzed in a macro-perceptual sense, but in a micro sense restricted to the area of the funtion's use.

Automatic edits functions however must be chosen, based on the type of spurious data present in the file and the relationship of these data to the entire file. This can best be understood through a discussion of automatic edits, three of which have proven to be most useful in the elimination of spurious data. They are Retouch, Rectangle, with "In" and Frame.

The retouch automatic edit function is especially suited for the removal of the spurious data type which appears as islands of erroneously coded data in the midst of valid data. The cartographer, in utilizing this function is required to select parameters which will have the effect of defining the dimensions and color of these islands which are to be eliminated through recoding by the command.

The height and width selected determines the maximum dimensions of an island of data which will be acted upon (recorded) by the command. All islands of data of a specified color which are less than or equal to these dimensions will be recoded as another color. This command will recode all data in the file meeting these specifications. The choice of these dimensions, however, is not always as clear cut as it may appear.

All files will contain spurious data and valid data coded as the same color. If a retouch command is applied to such a color and its effects upon the valid data represented by that color are not considered, some properly coded data could possibly be erroneously recoded. To minimize such occurrances, the raster file should be examined to determine which height and width dimensions will optimize the recoding of spurious data while leaving valid data relatively unaffected.

This command also allows the cartographer to select a replacement color to which affected data will be recoded. If, however, no replacement color is specified, the command will revert to a default option which causes the recoding of data according to the surrounding colors.

While this will, in most cases, recode data properly, there will be some instances when "islands" are erroneously coded. Similarly, if a specific color is chosen as the recoding color, the cartographer must examine the raster file to determine whether the color chosen will properly recode data.

To help minimize the elimination of valid data, the cartographer can specify one or two colors which must bound (be in contact with) the color selected for retouch in order for the command to recode it. The use of this option narrows the circumstances for which an island of spurious data will be recoded.

The second type of spurious data which appears in a scanner generated raster file takes the form (as described earlier) of frames and halos. This type of data normally collects around the edges of valid data in "color transition areas". The command frame is a useful tool for the elimination of this type of spurious data.

This command, when activated, will draw a "contour" of a specified width and color (referred to as the contour color) around a reference color (the color to be acted upon). There are two modes in which this command can be used. . . the underlap mode and the overlap mode.

The overlap mode will cause the contour color to be drawn around the reference color - this contour being drawn outward from the edge of the reference color. The underlap mode on the other hand, will cause the contour to be drawn inward from the edge of the reference color actually replacing the reference color. If both of these modes are utilized simultaneously, the contour will be drawn outward and inward from the edge of the reference color in the width specified by the cartographer. All of these modes of operation can be utilized in conjunction with a color selectivity parameter. This parameter, when chosen, will cause the frame command to act upon a reference color only when the color is in contact with a third color specified by the cartographer. The function of the color selectivity parameter is analagous to the selection of bounding colors with the Retouch Command in that it will narrow the circumstances under which this command will recode data.

The application of this function as an automatic edit can perhaps best be understood with an example:

If, within a raster file, the cartographer encounters spurious data in the form of halos coded as a blue color, and these halos are surrounding valid data coded red and both appear on a background of white, the underlap mode of operation could be applied to recode these data as either white or red. The spurious data color (blue) is designated as the reference color and white as the contour color. Through the use of the color selectivity parameter, the cartographer can specify the underlapping the blue with white where the reference color contacts red. In this manner, the color blue is replaced by white only where blue is in contact with red. Thus, the spurious data are recoded as white. Through applications similar to this, the frame command can be applied to a file to eliminate spurious data. Again, it must be stated that the file must be examined to determine the relationship of the spurious data to all other colors. If this is not done, after the application of the frame command, the cartographer will (upon examination of a file) discover the recoding of valid data.

The third command which has been found useful in the elimination of spurious data (of both types) is the rectangle command when used in conjunction with the "In" option.

The effect of this command on a raster file is very similar to that of the manual edit of the same name, with one very important exception. The "In" option allows the cartographer to designate those colors which are to be recoded. As long as spurious data appear as a unique color in the area selected for editing, only this color will be recoded, and other valid data of different colors are left unaffected. Thus, the only limiting factor in its use is that it should not be applied to an area in which spurious data and valid data are represented by the same color. To initiate this command, the cartographer inputs via the CRT command console, the coordinates of the limits of the rectangle, as well as a replacement color.

EDIT PROCEDURES

Throughout the discussion on automatic editing, the one characteristic of spurious data which has presented the most problems for the cartographer has been the representation of both spurious and valid data by the same color. This characteristic forces the cartographer to choose additional defining parameters, with the frame and retouch command which will differentiate the spurious data from the valid data of the same color. With rectangle in, the cartographer is forced to limit the action of this command to areas containing only spurious data of a color.

Manual editing, while allowing the cartographer to make this differentiation, is restricted in its use to small areas of the chart. These manual methods would prove too laborious and time consuming for the editing of an entire raster file strictly through their use. The editing of a raster file must then be accomplished through a mixture of both manual and automatic edits.

Utilizing the type of analysis described earlier, automatic edit functions should be applied first to a raster file. The type of function utilized and the parameters selected with it should be selected in an effort to maximize spurious data elimination while minimizing the recoding of valid data. Following the application of the automatic edits, manual capabilities should be utilized to clean up the remaining spurious data. In this manner, an efficient procedure for the elimination of spurious data is established.

With the file now free of spurious data, the modification of the file can commence.

CHART MODIFICATION

The chart modification phase of the production process involves making the changes necessary to reproduce a modified facsimile chart from a foreign chart.

The amount of modification necessary to change the format of a foreign chart to DMA standards will depend upon the country of origin of the source document. Naturally, a chart from Japan will require more modification than a British chart due to the required translation of identifiers in addition to changing the border information. The British chart will require no names translation but the descriptive information of the chart but will have to be modified.

Some of the modifications necessary for the reprinting of a foreign chart as a modified facsimile include:

1. The deletion of foreign stock numbers and their replacement with a new DMA stock number.

2. The deletion of the foreign chart number and its replacement by a new DMA chart number.

3. The addition of depth conversion scales (feet to meters to fathoms) if not present on a foreign chart or if the chart is not in English.

4. The deletion of foreign names and the replacement by the anglicized or transliterated version.

5. The compilation and addition of a glossary of native terms and English equivalents.

6. The addition of a warning notice on all DMAHTC charts with regard to "relying solely on any single aid to navigation".

These six changes only represent a portion of the changes necessary to reproduce a modified facsimile chart from a foreign chart. In addition to these format changes, a check must be run on the chart to determine whether any areas of the chart have been updated since its printing. If there have been changes made, then these too, must be included on the modified facsimile. The question confronting the cartographer then, is what is the most efficient means to accomplish the modification of a chart?

There exists a group of commands which are utilized to place the contents of a secondary raster file in to a primary file (for example, the raster file of a chart) at precise locations. Through the utilization of these "place" commands, the modification of a chart can be accomplished.

If the cartographer wishes to replace Japanese characters with their English translation at the correct point size and font, the following procedure can be followed.

A secondary file containing the translation of a specific Japanese word can be generated by scanning the English equivalent of this word. To properly insert this secondary file into the primary file at a specific location, the cartographer must determine the "pivot point" of the secondary file, and a reference point in the primary file. The "pivot" of the secondary file refers to the coordinates of a point in that file which the place command will relate to the reference point coordinates in the main file. That is, the pivot point in the secondary file will be placed at the reference point in the main file, thus positioning the secondary file at the determined position in the primary file. In the example of the English translation, the pivot point chosen would be the center coordinate of the file, and the reference point in the primary file will correspond to the coordinate position of that pixel which is centered in the Japanese word. The choice of these two points will assure that the English translation is placed where the Japanese characters existed before. In this manner, any type of lettering, seals, scales, or numbers may be placed into the primary raster file.

If it is desired to place type at an angle on the copy, it could either be scanned at an angle or rotated to the proper angle as part of the place commands operations.

There is another group of commands currently under investigation which, when fully implemented, will allow the cartographer to place text directly into the primary file without having to scan a new set of data for each chart. The text command group will allow the compilation of a font library. These various fonts can then be accessed letter by letter and placed, via a text command, into the primary raster file.

In addition to these font libraries, symbol libraries and generalized information which must always be placed on a Modified Facsimile are being compiled in separate files. These files will comprise a library of standard notes, symbols, and text from which the cartographer can access and use in the modification of foreign charts.

COLOR SEPARATION FILES AND THE GENERATION OF REPRODUCIBLES

Scanning, editing, and modification have all been utilized for one purpose: to produce color-separated reproducibles from a paper chart which can then be used to reprint a foreign chart as a modified facsimile.

One method by which the cartographer can extract the information present in the "complete" raster file for use with the Laser Plotter is by generating separation files. One file for each separation to be exposed by the Plotter must be generated with each file containing all the information represented by a color or colors. Typically, if a raster file contains four colors, four files will be generated. It is possible, however, to combine various colors in one file.

The command which is utilized in exposing the separation files is named (aptly enough) "Expose". Aside from actuating the plotter for the exposing of film, this command has another unique attribute - it allows the cartographer to adjust his separation file dimensions. Most paper copy charts will expand or shrink. Thus, the scanned dimensions of a paper chart will not be representative of the chart's true dimensions. To alleviate this condition, the dimensions of the separation files can be adjusted to represent the true dimensions present on the paper chart before any shrinkage or expansion took place. After this adjustment is completed, the outputting of reproducibles can take place.

A sheet of film is mounted on the rotating drum of the Laser Plotter, and as the plotter head passes over the film, the laser will expose the contents of the separation file on the film. The laser is not actually mounted in the plotter head, but through a series of optics and mirrors, the laser beam is projected onto the film via the head. The laser plotter is capable of producing both positives and negatives, however, there is one laser characteristic which in some cases will make the production of positives more desirable than negatives.

The laser plotter, when exposing a positive, will add a half of a point of thickness (approximately .00005 of an inch at forty PPM resolution) on each side of each line exposed. This has an enhancing effect on the production of positive reproducibles, but can cause fine lines on negatives to become filled in.

CONCLUSION

DMAHTC acquired the R250/MS to facilitate the production of Modified Facsimile Charts. Currently, a preliminary evaluation indicates that the system is capable of producing the modified color separated reproducibles required for the production of modified facsimile charts.

Editing of a raster file remains the most time-consuming phase of the production flow. Standard operating procedures to reduce edit time and scanning procedures to reduce the amount of spurious data are currently being established.

The addition of font, symbol, and text libraries will further increase the capabilities of the R250/MS.

Following the establishment of the system in the modified facsimile reproduction process, other avenues of cartographic applications will be explored.

LITERATURE CITED

1. "Cartographic Digital Image Processing and Production System", Sci-Tex Corporation Limited, (No Date), p. 5 Section 1.1.

2. "Cartographic Digital Image Processing and Production System", Sci-Tex Corporation Limited, (No Date), p. 8-9.

3. "Cartographic Digital Image Processing and Production System", Sci-Tex Corporation Limited (No date, p. 15.

4. "Cartographic Digital Image Processing and Production System", Sci-Tex Corporation Limited, (No Date), p. 5, Section 1.3.