NATIONAL OCEAN SURVEY--AUTOMATED INFORMATION SYSTEM[*]

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Introduction

The Marine Data Systems Project (MDSP) of the National Ocean Survey (NOS), National Oceanic and Atmospheric Administration (NOAA), was formed in 1970 to design, develop and transition to operational use a balanced, computer-assisted nautical charting system. The system development was designed to minimize impact on concurrent production activities, and to arrive at a system which could reduce or eliminate the steadily increasing backlogs of unprocessed data while responding in a timely manner to dynamic charting requirements. Incremental transition of the various subsystems to operational use was planned as they became operational. The various subsystems of the computer-assisted NOS Nautical Charting System are: (Slide 1)
  -Data Acquisition and Processing
  -Evaluation, Storage, and Compilation
  -Automated Graphics
  -System Management
1. The Data Acquisition and Processing Subsystem includes basic hydrographic and photogrammetric surveys and subsequent processing of collected survey data

[*]For information about the slides, please contact the author.

through such steps as smooth-plotting, editing, and verification. The hydrographic surveys are conducted primarily by ships and launches based at the Atlantic Marine Center (AMC) in Norfolk, Virginia, and the Pacific Marine Center (PMC) in Seattle, Washington.

The field Data Acquisition Subsystem includes more than 30 HYDROPLOT units and the survey processing subsystems which are operational at both AMC and PMC. The PMC sub-system, operational since 1975 with a Harris computer and stand-alone Xynetics Plotter, has a newer Calma Digitizing System. This System allows production of complete hydrographic survey tapes which can be readily entered as new data into the central data base. At each of the marine centers there is also a Wild B-8 stereo photogrammetric plotter for compilation of digital topo-graphic information from aerial photographs.

Data preparation and graphic conversion for other source input to the data base is accomplished at NOS Headquar-ters in Rockville on a five-table digitizing system. Also accomplished at Rockville, Maryland, is an analysis of tidal and lake level data collected during survey op-erations which is used to correct depth soundings at the marine centers before data is entered into the data base.

2. The Evaluation, Storage, and Compilation Subsystem provides quality control of NOS conducted surveys, eval-uates nautical chart data from other sources, reformats data as necessary, stores, retrieves, and updates both NOS-originated data and other source data, and compiles nautical charts. Recently established quality control procedures will be consistent with the system final con-figuration and will require little or no modification.

3. The Automated Graphics Subsystem produces nautical chart drawings as well as negatives used to produce printing press plates. Automated graphics products are produced at NOS Headquarters on two Calcomp flatbed plotters, as well as on the one-of-a-kind laser raster production plotter built by MB Associates. This plotter produces reproduction quality full size chart negatives or positives for direct printing plate production. (Slide 2)

4. The Management Subsystem includes such activities as planning, scheduling, budgeting, management informa-tion, system logistics, training, etc. This system is

centered at NOS Headquarters, but responsibility for portions of it is delegated to the marine centers. It is an integrated management system managed by NOS Headquarters.

The Automated Information System
The Automated Information System (AIS) is a system implemented by the Planning Research Corporation/Information Sciences Company (PRC/ISC) under contract to the U.S. Department of Commerce, NOAA, in response to NOS design requirements. The primary objective of the system is to provide nautical chart cartographers with a computer assisted chart compilation and maintenance capability. Two basic concepts in the development of the AIS are the universal, geographic feature oriented data base and the concept of continual update and maintenance. (Slide 3) All incoming source material is evaluated for entry into the data base as soon as possible after it is received. Since there is only one record per feature, all charts displaying that feature are corrected at the same time. Different levels of density are selected for large, medium or small scale charts. The source material is handled only once with application and review for all affected charts at the same time, by the same cartographers. (Slide 4) The AIS data base contains the following four types of data: .

1. New data--from a new source document.
2. Published data--depicted on a published chart
3. Non-published data--not on a published chart
4. Archival data--superseded data

New, Published, and Non-published data reside on disks, but archival data are on magnetic tapes. For purposes of automated nautical chart production, areas of production responsibility within NOS are divided into seven geographic areas of approximately equal chart revision activity in terms of number of changes to charts per unit of time:

1. Northeast Atlantic coast   4. Gulf of Mexico
2. Mid-Atlantic coast   5. Pacific coast
3. South Atlantic coast and   6. Alaska and Pacific
      Caribbean   7. The Great Lakes

The six basic types of overlays can be selected for compilation:

1. Base Control   2. Waterway   3. Navigation
4. Topography   5. Labels   6. Special Overlay

Data Base
By law, Federal Government publication of a nautical
chart makes it a legal document, and if the omission of
known hazards contribute to an accident, the Government
may become liable. This puts NOS/AIS data base access
in a unique category. No changes may be entered without
a supervisory review. As a means of ensuring that only
valid changes are made, a separate work file is created
for the cartographer, which is manipulated, edited,
and/or changed. A supervisory cartographer is required
to validate changes prior to the data base entry. The
security provisions are incorporated into the AIS system
software.

The pacing element of the NOS AIS is the arrival at NOS
Headquarters of new source documents such as new NOS
Hydrographic Surveys, U.S. Army Corps of Engineers blue-
prints, Notices to Mariners, Chart Letters, etc. The
document may or may not be in digital form, and may re-
quire digitization. A report is then generated to
notify the cartographer that new data is available. The
cartographer initiates a work file request for the new
data, as well as any published, non-published, or even
archival data to which the cartographer may wish to re-
fer. Necessary changes are made to this data base work
file, interactively. After supervisory review, the data
base is updated, and the data awaits a chart printing
cycle or more new data. When a chart is due for print-
ing, the digital representation of the chart can be re-
trieved and input into a graphics program to produce the
chart negatives. This also provides the flexibility to
custom design or reformat existing or new charts and
other products which are not tied to an existing
graphic. (Slide 5)

AIS Site
The NOS/AIS is located in NOS facilities in Rockville,
Md., and, when completed, will have data storage, cen-
tral computer processing, and 10 cartographic work
stations (Slide 6). The central site computers and two
work stations are installed in the completed site. Cen-
tral site data base managment and work station software
were provided under contract. The central site contains
two Varian V-76 computers, each with 128K bytes of
memory, interfaced to work as either master-slave or

separately. There are also five of the 16 planned 300-megabyte data base Eagle disks containing 128.9 million words of on-line memory. An intercomputer link (ICL) provides direct memory-to-memory transfer between the central and the work station computers. Each work station consists of a Varian V-76 computer with 96K words of memory, a Calcomp T-50 work station disk, a Bendix Datagrid DTS1.04, and two CRTs. One station has two Sanders SA 900 color graphic refresh CRTs, while the second has one Sanders color refresh CRT and one Tektronics 4014 graphic storage CRT. Each station has a hard copy device (one is a Varian STATOS 4122HS, and the other is a Tektronics 4631).

● Work Station #1--A five color Edit CRT (KRATOS) with a sufficiently rapid refresh rate that the display appears stable.

--A monochrome storage tube CRT (Tektronix 4014) is used as a reference screen, for textual communications with the operator, to display data base records, for on-line prompting, and operator responses.

--A Tektronix plotter provides a scaled reproduction of the Tektronix CRT image without computer intervention.

--A Bendix digitizing table is used for chart regis-tration and to define data sets for display. The cursor has two operating functions, one of which is an internal reset or "clear" and the other a "set" command which re-cords the cursor position.

--A keyboard is used for cartographer communications with the system. There are also two sets of 16 keys which serve as a function control devices. One set of keys is back-lighted under program control.

--A teletype terminal is used for system startup, shutdown, computer system logging, etc.

● Work Station #2--Essentially the same as #1 but with two KRATOS five-color CRTs and a STATOS 4122/45 plotter.

● AIS Work Station Operation A cartographer begins an editing session with a Log-On sequence by entering the number of the request that generated the Work File, em-ployee number and security identifier. Data can be selected from the Work File for display on the work

station CRTs by compilation overlay, data type, display area, cartocode, and chart-inset-extension number. Menus to support the cartographers selection process are displayed on the Reference CRT.

The cartographer's work file is retrieved from the data base in a 60 by 60-inch grid. This is further segmented into 2-inch-square work blocks for data organization and display. Latitude and longitude coordinates of features are converted to cartesian grid X-Y coordinates in units of scaled inches, based on the scale of the retrieval.

The cartographer normally manipulates only the keyboard and cursor. To display data on the screen, the digitizing table must be registered to the work file coordinates. The projection type and retrieval scale are established by the original request. The first step in registering is to clear the table by positioning the cursor at the lower left corner of the digitizing table using the "L" shaped template as a guide. Depressing the red cursor button causes a prompt for latitude coordinates to be input from the keyboard, followed by longitude coordinates. The cursor is now placed on the chart point corresponding to the entered geographic coordinates and the blue button on the cursor is depressed. A second point is entered in the same manner, and NEW LINE is selected, which completes the registration. After the table has been registered, any point on the table can be located and associated data displayed by placing the cursor on the desired point. The data is retrieved from the work file, with data density related to the zoom factor. At this point, the display is directed to either the Edit or Reference CRT, which causes a prompt for the types of data desired on the display. Any number of the following types of data which correspond to those previously described, but with a finer breakdown, may be selected:

1. Published
2. Unpublished
3. New
4. Transactions

5. Suppressed
6. Selected
7. Pre-selected

Up to ten specific types of cartographic features may be displayed simultaneously. This allows control of the relative density of features to minimize clutter during editing. Overlays such as navigation, waterway, topo-

graphic, chart base, and labels may be selectively
displayed or deleted.

● Editing Functions The basic cartographic action in
editing is to locate a feature on the display screen,
perform an operation on it, such as MOVE, ROTATE, etc.,
and then change its status, e.g., from non-published to
published. The cartographer may select hardcopy of the
CRT displays, intensity, color, and listings of data or
charts affected by the displayed data. The basic avail-
able functions are:

--FIND POINT--correlates the point designated by the
cursor with the same point on the display screen. The
located feature blinks on the CRT display. End points
of lines can be located and edited as point features.
Once a point is identified, the cartographer has the
following options:

RELEASE	PUBLISH	NEW CARTOCODE
ROTATE	SUPERSEDE	PUBLISH NOMENCLATURE
TEXT	MOVE	NON-PUBLISH

Depressing FIND POINT a second time will exit from this
function. If no other features can be found, exit is
automatic.

--RELEASE is used in conjunction with FIND POINT, FIND
LINE, FROM/TO, and TEXT. Depressing RELEASE causes a
new search to find and blink another feature within the
search tolerance.

--MOVE S/N is used in conjunction with FIND POINT to
move a blinking feature on the screen display by use of
the four arrow directional keys on the keyboard. The
feature is not moved in the work file until it is
PUBLISHED.

--ROTATE permits CLOCKWISE, COUNTERCLOCKWISE or ROTATE
HOME functions to be used in conjunction with FIND
POINT, but only when a blinking feature is displayed on
the CRT. One depression of the key will rotate the fea-
ture by two degrees and holding the REPEAT key down will
cause continuous rotation. Activation of the ROTATE
HOME key will return the feature to its original posi-
tion. The feature is not rotated in the work file until
it is PUBLISHED.

--NEW CARTOCODE permits the cartographer to interac-
tively change the chart symbols of a feature.

--FIND LINE functions for lines the same as FIND POINT.

--FROM/TO is used for editing line features in conjunc-
tion with FIND Line. In response to an audible signal,
the cartographer places the cursor on the position where
the line is to terminate, and the coordinates are en-
tered by depressing the blue push button. The selected
location is shown by a blinking symbol which may be in-
put by depressing the FROM/TO key a second time. It is
now possible to activate the PUBLISH, NON-PUBLISH,
SUPERSEDE, or RELEASE functions.

--TEXT is used in conjunction with FIND POINT or FIND
LINE, and is valid only when there is a blinking feature
on the display screen. Selection of the TEXT function
results in all GP BASE records associated with the
selected feature being displayed on the Reference screen
for review.

--PUBLISH NOMENCLATURE allows publication of only the
nomenclature associated with a point feature.

Summary
The NOS AIS, developed by PRC/ISC, is an interactive
cartographic production system which supports continual
data base update so cartographic products may be pro-
duced when they are required, without the time delays
normally associated with chart production. The data
base integrity is protected to ensure that the legal
status is not subject to erroneous factors by creation
of a work file for the cartographer's use. The final
output product of the AIS is a completely laser-plotter-
produced set of color separation negatives/positives
which are used directly to make the final lithographic
printing press plates for nautical charts. In addition,
the AIS is capable of providing other products such as
management information, plots and data listings to sup-
port bathymetric mapping, custom designed plots, tapes
and data listings for outside users, and products to aid
the hydrographer. NOS began using the AIS test data
base for charts in the Gulf of Mexico in March 1978. As
a result of this contract NOS now has an operational
central site data base system and two operational proto-
type work stations. NOS plans to begin loading the en-
tire Gulf of Mexico data file on the AIS Data Base in
November 1979.