

THE NATIONAL OCEAN SERVICE DESIGN FOR  
AUTOMATED NAUTICAL CHARTING SYSTEM II

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ABSTRACT

The National Ocean Service (NOS) has the mission of providing nautical charts and related information for the safe and efficient transit of the Nation's coastal waters and marine inland waterways.

In 1975 the National Ocean Service initiated the design of a computer-based system to provide for the storage of nautical chart information and automated assistance to the cartographer for compilation of nautical chart products. The Automated Nautical Charting System was implemented in 1978.

Efforts commenced in late 1984 to design a replacement system which would provide not only the functional capability and capacity to handle the requirements of nautical production, but also the needs of other users for nautical charting data.

The conceptual view of the next generation system, the Automated Nautical Charting System II (ANCS II), recognizes the fact that the nautical chart is only one of the many marine products that may be produced from a digital, chart-independent, data base of marine information. It is designed to benefit from the separation of the data management and chart production functions to lessen the impact of each function on the other. Another benefit is the reduction in the amount of time that data are unavailable (i.e., locked-out) to other users during chart compilation.

The NOS suite of 1,000 nautical charts may contain as many as seven or eight overlapping charts at different scales for certain areas. The design of ANCS II will incorporate in the automated chart compilation process the principal of update "through the scales." That is, application of digital marine information from the largest to the smallest scale using the set of information from the previous larger scale, thereby improving the efficiency of the system and ensuring greater standardization of chart products.

## INTRODUCTION

The National Ocean Service (NOS), under the United States Department of Commerce, has the responsibility of providing nautical charts, related marine publications, and information required for the safe and efficient transit of the Nation's coastal waters and inland waterways. NOS marine products directly support national commerce, development of offshore resources, and defense of the Nation's coastal areas.

In 1975 the NOS initiated the design of a computer-based system to provide for the storage of nautical chart information and automated assistance to the cartographer for compilation of nautical chart products. This design culminated in the implementation of the Automated Nautical Charting System (ANCS) in 1978.

Technological advances in automated mapping and charting equipment coupled with the introduction of new automated mapping concepts have yielded capabilities far beyond those envisioned in the original ANCS. Therefore, a modernization effort, termed ANCS II, has been designed to reap benefits from state of the art hardware and software. In addition, ANCS II will expand well beyond the concept of a chart product support system to that of a broad information system for the support of multiple products and users of digital navigation data.

The ANCS II is designed to have the capability and capacity to handle the total requirements of NOS nautical chart production and the requirements of external users of digital marine information (to the extent the latter can be identified and defined). The ANCS II has a modular design to facilitate incorporation of new requirements and will allow for enhancements that cause as little impact as possible on production operations.

The ANCS II is part of an overall nautical charting modernization program and as such will directly support and be integrated with two major NOS data processing systems currently under development: the Shipboard Data System III (SDS III), a digital hydrographic data acquisition and processing system to be deployed on NOAA hydrographic survey vessels, and the Integrated Digital Photogrammetric Facility (IDPF), a shore based photogrammetric data processing system for compilation of digital topographic and photobathymetric survey manuscripts. Both systems will rely heavily on the contemporary information contained in the ANCS II data bases.

## DATA MANAGEMENT

The NOS is responsible for charting approximately 2 million square miles of coastal area. This area contains more than 40 million cartographic features of interest to charting and

navigation. The management of this vast amount of information to meet the growing demand for digital navigation related products, as well as to enhance charting productivity, is central to the mission of NOS.

The current data management system, which was designed to support paper chart production, is not amenable to the changes required for a focus on digital data dissemination. In order to accommodate this change in emphasis, a change in the data management concept was required. That change required the logical separation of two distinct functions:

- o The management and maintenance of marine navigation information, and
- o The management and maintenance of chart graphic information.

Early thinking saw the inherent properties of both incorporated within the physical processing confines of one large data base system. However, experience with ANCS has proven that, because of the distinctly different demands and requirements associated with each, the two functions cannot be adequately performed without performance degradation of each other.

The daily processing of source information and the timely update of the marine Navigation Information Data Base (NIDB) will continue unaffected by the demands and requirements of scheduled product maintenance at the Chart Graphic Data Base (CGDB). The CGDB will rely on the contemporaneous nature of the NIDB and in the purest sense will be considered a user of the NIDB. The following text describes the major components of the ANCS II design and the functions of each.

#### SYSTEM COMPONENT DESCRIPTION

The ANCS II design diagram (figure 1) reflects the five major activities and information flow.

- o Document evaluation - the determination of the validity of the source document and the level of usefulness of the included information. This is a data certification process.
- o Data selection - the process of automated evaluation and selection of specific information from the contents of the valid source document with interactive selection approval by the cartographer.
- o Data base maintenance - the process of updating the existing data base of navigation information by interactive addition and deletion of selected features and associated information.

AUTOMATED NAUTICAL CHARTING SYSTEM  
ANCS II

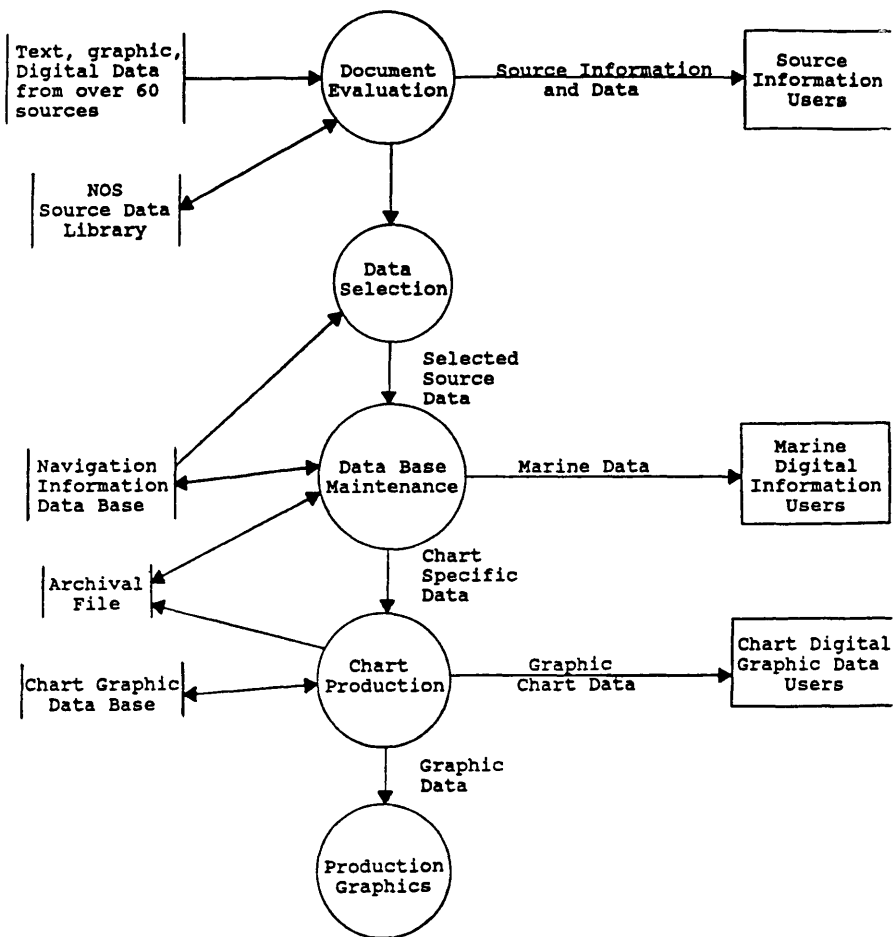


FIGURE 1

- o Chart production - the process of automated compilation of the chart graphics from digital information and the storage of the digital graphic representation.
- o Production graphics - the creation of graphic reproducibles.

### Document Evaluation

Document evaluation is one of the major concerns being addressed in the design of ANCS II. The current ANCS system does not provide interactive facilities to assist the cartographer during the registration, validation and subsequent processing of new information. ANCS II has been designed as an interactive environment to assist the cartographer in a predefined evaluation process and to serve as a management tool for: a) the tracking of documents, b) recording events during evaluation, c) data selection and reduction, d) application of documents and their contents, and e) scheduling of resources.

Information affecting NOS charting products is received by NOS from over 60 different sources. About 80 percent of the documents received are from sources external to the Agency. The information received from external sources and new source information acquired by internal NOS hydrographic and topographic surveys and field examinations will be inspected and an entry created in a Source Document Index File (SDIF) describing characteristics of the document and the information it contains. ANCS II, utilizing an interactive process supported by the index of previously received and evaluated source documents, will assist the chart specialist in the determination of the validity of a new external source document. This determination will be made by comparing the new document against existing and other new documents which have been entered into the NIDB. Redundant documents and those that do not contain information useful to charting will be rejected or redirected to the appropriate office. Internal source documents are entered directly into the NIDB.

The source document and its contents are incorporated into a Source Data Library (SDL) for storage and subsequent retrieval of source information as required. The Library is a repository for both physical documents and digital storage medium indexed by document number, document type, and date.

### Data Selection from External Source Documents

The cartographer will initiate the process of source information selection and application by an interactive query requesting information on a particular source document or the geographic area of interest. The cartographer will be informed of the availability and status of newly entered source documents and presented, if requested, with a display of a graphic index

containing a general feature outline of the area and relevant document limits. Using the graphic index and SDIF information, the cartographer will interactively build and qualify a request for retrieval of the required new source information, if in digital form, and current NIDB data for the area. Automated assistance in retrieval request building will aid in keeping the volume of data retrieved from the data base to a minimum and improve the human interface.

After the retrieval request has been accepted by the user, the data retrieved will be copied to a working file. Source document data residing in the SDL, already in digital form, will also be copied into a working file. Digital data retrieved from the SDL will undergo an automatic transformation sequence to convert the control and translate the contents of the digital source document to the same coordinate system and graphic characteristics as that of the data base. The source document line data will be generalized, the soundings will be preselected, and the depth curves created. If a source document is not in digital form, the retrieved data base work file will undergo the equivalent transformation so that the information can be displayed at the work station in the units and with the control of the physical source document for digitization and data selection from the source document.

The transformed digital source document file and the data base work file are then overlaid and displayed at the work station. Automatic editing is performed to the extent that document features are added and corresponding data base work file features are deleted. The user can revise the automatically edited work file and perform other editing to tie linear information and revise the disposition of features for which a predetermined editing sequence has not been established. If the source document is not in digital form, the work station will allow precision entry of features into the data base work file.

Upon completion of the editing session, the user will have the capability to generate a textual or graphical representation of the proposed transactions prior to update of the data base. The user will have the capability, prior to acceptance of these transactions, to restore or undo any edit performed.

Documents vary over a wide range as to content, form, size and complexity requiring various degrees of precision for digitization and cartographic sophistication for evaluation and selection. In order to utilize resources efficiently, ANCS II will provide a variety of work stations, each best suited to a particular task.

#### Data Base Maintenance

During the NIDB update process, a Feature History File (FHF) and a Notice to Mariners File (NMF) will be updated based upon the

transactions. Should a feature be deleted for any reason, it will be moved from the data base to the FHF for permanent storage. Should an addition or deletion, either through automatic editing or manual editing, result in a critical difference between the current representation of the data base and the transaction applied to the data base work file, the items of a critical nature, flagged by the user, will be copied to the NMF. An entry made into the SDIF is updated to reflect the current evaluation and data base application status of the source document. The NIDB will be updated to reflect the status of the data base.

The NIDB is a geographically oriented digital data base consisting of geographic positions of features and their associated attributes. The NIDB will provide the capability to efficiently access a logical subgrouping (as shown in table 1) of features, which with the present system, is a difficult task.

### Chart Maintenance

After information is applied to the NIDB it becomes available to the Chart Production Subsystem (CPS) for application to the nautical charts contained in the CGDB.

The CGDB is a digital data base containing the information required to produce the published chart graphic for the approximately 1,000 NOS nautical charts. The data consists of a link to the NIDB and instructions for producing the graphic attributes needed by the cartographer to make cartographic decisions during the compilation processes. An interactive retrieval initiated from the NIDB will retrieve only new features entered since the last chart update or a specified date. The retrieval will be qualified by geographic limits; usually the limits of the largest scale chart in common with the NIDB revisions. Any features previously retrieved for chart application will not be included in the current retrieval. This eliminates the possibility of NIDB features being retrieved and applied more than once to a chart.

The features retrieved are transformed into the proper chart symbols based on the coded information in the feature record. The largest scale chart parameters govern the portrayal characteristics of the data retrieved; scale, control, and screen orientation (for skewed charts). Additional processing performs line and symbol generalization, and converts all NIDB depth values to the units of measurement on the chart (soundings). Initial application is rule based, but will allow the cartographer full latitude to apply the final portrayal of data.

The link between features in the NIDB and the CGDB is the geographic position which was entered into the NIDB and the system derived feature code. The CGDB will record both the

## PROPOSED MIDE FEATURE CLASSIFICATION

### Classification Code

1. NAVIGATION
  - A. Aids
    1. Lights
    2. Buoys
    3. Daybeacons/Markers
    4. Radio Aids
    5. Fog Signals
  - B. Demarcation
    1. Boundaries
    2. Administered Limits  
Cautionary/Information
    3. Anchorages
    4. Recommended Routes
    5. Channels/Dredged Areas
  - C. Marine Assistance
    1. Stations/Other
    2. Facilities
2. HYDROGRAPHIC
  - A. Bottom
    1. Soundings
    2. Depth Curves
    3. Bottom Quality
    4. Cleared Areas
  - B. Features in Water
    1. Manmade
    2. Natural
3. TOPOGRAPHIC
  - A. Coastline
    1. High Waterline
    2. HWL Associated
  - B. Culture
    1. Prominant Structures  
Behind HWL
    2. Other Feat/Limits  
Behind HWL
    3. Structures Over  
Water
  - C. Natural
    1. Limits (Surface)
    2. Drains (Non-Nav)
  - D. Relief
    1. Contours
    2. Features
    3. Spot & Trig Stations
4. CHART SPECIFIC
  - A. Nomenclature
    1. Legends
    2. Blocked Text
  - B. Scales
    1. Other Scales
    2. Magnetic Variation
  - C. Symbols/Annotation
    1. Feature Enhancement
    2. Chart Format
    3. Generated Data

TABLE 1



position at which a feature is to be displayed and the original geographic position, so that the link is unaffected even if the feature symbol is moved for cartographic reasons. Features deleted from the NIDB are retrieved with the new features and matched with charted symbology having the same geographic position and symbol code. All matches to be deleted are graphically presented on the edit display for cartographer approval. All new features are added to the chart allowing the cartographer to eliminate excessive features. Features retained are spatially oriented to avoid overlapping other symbology. Coded text extracted from the NIDB record is displayed in the correct font and character size for the symbol to which it is attached. The cartographer will abbreviate the text, if necessary, and orient it to best describe the feature: arc, stacked, or sloped. The system will make the basic attempt to assign the best location and configuration of the text. Text that cannot be coded will be available in the record on demand to allow the cartographer to create additional text.

After application of the features to the largest scale chart, the system will model the selected contents of the initial application and any features retrieved not within the limits of the initial chart for subsequent application to the next smaller scale chart in common, and the procedures will be reinitiated. This continues until all affected charts have been revised. Encoded in the basic design of the CGDB will be the rules for through-the-scales application of features. The results of this process yields uniformity and consistency.

#### Graphic Production

The updated graphic representations will be subsequently retrieved for color plate production on the SCITEX Response 280 system where esthetic corrections will be performed to ready the graphic for raster plotting of negatives and positives. The CGB will also support internal and external special requests for high resolution graphics.

#### SUMMARY

The current Automated Nautical Charting System was designed in 1975, primarily to support the automated compilation of the paper nautical chart. The system has limited capability to respond to the increased requests for digital chart information.

The modernization of technology and the conceptual approach taken by the ANCS II effort will allow the National Ocean Service to meet the need for digital charting products of the future and enhance the productivity of the nautical charting process.

## Reference

Swisher, W.G. (1981) National Ocean Survey Automated Information System. Monaco, International Hydrographic Review.