EXPERIENCES OF
IMPLEMENTING A GIS-SOFTWARE (FINGIS)
FOR NAUTICAL CHARTING

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Abstract

The Hydrographic Department of the Finnish National Board of Navigation has developed a system for computer-assisted production of nautical charts. New nautical charts (ready-to-print films) will be produced by this system. These new nautical charts will also be updated by the system. The database software for processing chart data is based on a commercially available software, the FINGIS. The system is based on graphic workstations connected to MicroVax mini-computers with a local area network or terminal lines and on various plotting devices. The system should be ready for production during the first half of the year 1989.

This paper describes the experiences of the implementation and use of the FINGIS software for the production of nautical charts.

1. INTRODUCTION

Nautical charts

The Hydrographic Department of the Finnish National Board of Navigation publishes some 130 sheets of nautical charts at scales between 1:10,000 and 1:500,000. New prints or editions of these sheets are published almost annually. Most Finnish charts are printed in five colours. These colours are: black for lines, symbols and texts, green gray for land tint, yellow for shallow water tint, warm red and green for navigation information. For yachting charts, only three colours are used. On these charts, navigation information is printed in black colour.

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Also, charts printed in one colour are in use. On these charts, the colour masks are printed with screened black areas. Finnish nautical charts are printed in the format of 70 cm × 100 cm and yachting charts in the format of 40 cm × 60 cm.

Development of Finnish chart production system

The Hydrographic Department has developed software for processing digital hydrographic data since 1975. Since that time it has also developed some separate programs to help produce nautical charts. These include, for instance, the computing and plotting of borders, Decca lattices and some symbols for nautical charts.

In 1980, the Hydrographic Department began to develop software for computer-assisted production of nautical charts. The main reasons for this was the need to utilize digital topographic data and hydrographic survey data and to produce more accurate, higher quality and more precisely updated nautical charts in a faster and more flexible way than previously. The Hydrographic Department has been in close co-operation with the Finnish National Board of Survey and adopted the basic database philosophy they have in use. The basic database software was rewritten and features required in nautical charts were added. In addition, the Hydrographic Department wrote programs for interactive digitizing and editing of chart data and also made programs for plotting nautical sheets. The software was capable of manipulating almost all information on nautical charts except areas (colour masks), texts and some special symbols. By using this software, there have been partly produced some 20 sheets of nautical charts. No updating of these sheets was done with this software. This software was written in FORTRAN IV and it was running on a Hewlett-Packard 3000 computer. Drawings were made on a Kongsberg DC300 drawing table using a photo head. Line drawings for colour masks were scribed and the masks were made by the cut-and-peel method.

During 1986, it was realized that the old software for production of nautical charts was not good enough for all the needs of the Hydrographic Department. The main disadvantage of the software was the lack of area manipulation. It was reasoned that it would be too laborious for the small staff of the Hydrographic Department to develop and maintain the existing software. So it was decided to select commercially available software as the base of the chart production system. While developing software, quite an amount of knowledge has been gathered on how to design a system for nautical charting. The Hydrographic Department has studied, developed and also implemented many good methods and algorithms for nautical charting, e.g. how to organize chart databases, sub-routines for plotting borders, lattices, symbols and texts with different fonts on nautical charts, Mercator transformations, event history log files, lay-out databases, masking of lines below texts and so on. When selecting software for nautical charting, there was no software available that would fulfil these requirements for the system. All the software on the market needed much modification and further development.

The Finnish Hydrographic Department selected the FINGIS software to be developed for nautical charting. The name FINGIS is an abbreviation of the Finnish Geographic Information System. This software is developed by the Finnish

National Board of Survey. The FINGIS software is designed especially for topo-graphic and other cartographic purposes. The Board of Survey has modified the software for nautical charting according to specifications established by the Hydrographic Department.

The main reasons for selecting the FINGIS software were: (1) Familiarity with the software. The development of FINGIS had been followed closely. So the design principles and structures of the software were known quite well. (2) The software is relatively hardware independent. Almost all the FINGIS software is written with the standard FORTRAN-77 language. The software is not particularly bound to any special hardware or peripheral devices. It has device drivers to most of the peripheral devices needed. Especially, there is an interface to the Scitex plotter. (3) It was hoped that the development of the software would be easy. Close connections exist with the Board of Survey. It is therefore easy to discuss things and make modifications in the FINGIS software. Small modifications can be made to the software directly by telephone lines from the Board of Survey. (4) When using the FINGIS, there is good compatibility with other chart data. The Basic Topographic Map of Finland will be in digital form in FINGIS databases. This is the main source of land information for nautical charts. It is also possible to convert old databases into FINGIS databases. (5) The cost of the software was low as the Hydrographic Department only had to pay for the modifications and the maintenance of the software.

The Hydrographic Department has also changed its computer equipment to MicroVax (VMS) computers. For the processing of hydrographic survey data and for the production of nautical charts, it now has a MicroVax 3600 mini-computer connected by a Local Area Vax Cluster (LAVC) with two Vaxstation 3200 work-stations. These workstations also contain Calcomp 9100 series digitizing tables. The MicroVax 3600 has a 32 Mb cpu memory, 2.1 Gb disc memories and necessary mag-tape and printer equipment. The Vaxstations have 8 Mb memories and 159 Mb local disc memories (used only for swapping and paging). Further, the Department has two other workstations, each of which contains a Tektronix 4125 or 4111 colour screen and a Calcomp 9000 or 9100 series digitizing table. These workstations are connected as normal terminals in the MicroVax 3600 computer. For proof plotting, there is a Calcomp 1076C pen plotter and it is intended to buy an electrostatic colour plotter. Films for printing are made by a Scitex Response 350 system with an ELP II laser plotter.

The FINGIS software is used for manipulating cartographic data. The Hydro-graphic Department uses the FORTRAN-77 language for programming its software for the processing of hydrographic survey data. Also, the FINGIS device drivers are used to control the various cartographic peripheral devices. For attribute databases, it has been decided to use Oracle database software and, for adminis-trative and document data processing, All-in-One software connected with WordPerfect text processing is used. Figure 1 presents a scheme of the equipment for the processing of hydrographic and chart data.

BOARD OF NAVIGATION

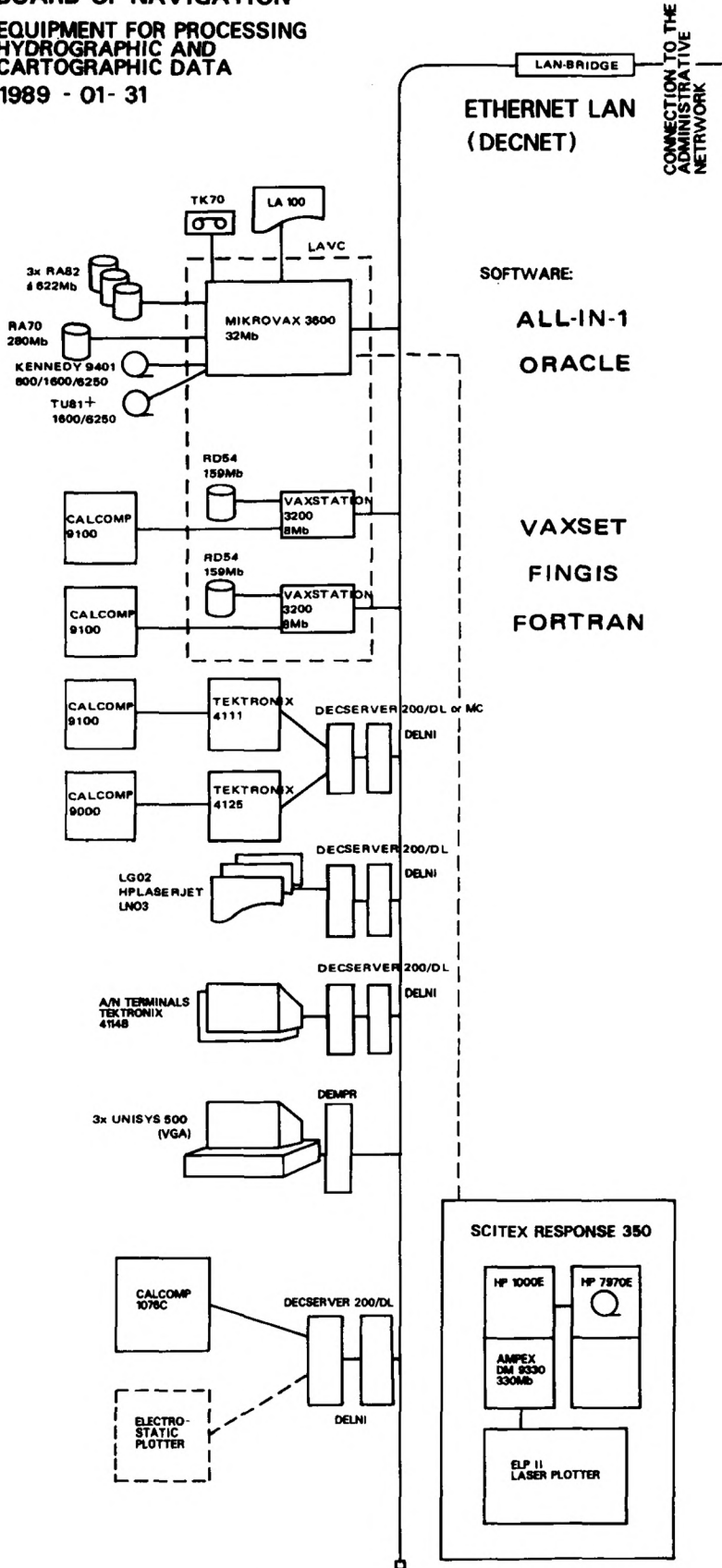**EQUIPMENT FOR PROCESSING HYDROGRAPHIC AND CARTOGRAPHIC DATA**

1989 - 01- 31

LAN-BRIDGE

CONNECTION TO THE ADMINISTRATIVE NETRWORK

ETHERNET LAN (DECNET)

TK70   LA 100

LAVC

3x RA82 á 622Mb

RA70 280Mb

KENNEDY 9401 800/1600/6250

TU81+ 1600/6250

MIKROVAX 3600 32Mb

SOFTWARE:

ALL-IN-1

ORACLE

RD54 159Mb

CALCOMP 9100

VAXSTATION 3200 8Mb

RD54 159Mb

CALCOMP 9100

VAXSTATION 3200 8Mb

VAXSET

FINGIS

FORTRAN

CALCOMP 9100

TEKTRONIX 4111

DECSERVER 200/DL or MC

DELNI

CALCOMP 9000

TEKTRONIX 4125

LG02 HPLASERJET LNO3

DECSERVER 200/DL

DELNI

A/N TERMINALS TEKTRONIX 4148

DECSERVER 200/DL

DELNI

3x UNISYS 500 (VGA)

DEMPR

CALCOMP 1078C

DECSERVER 200/DL

ELECTRO-STATIC PLOTTER

DELNI

SCITEX RESPONSE 350

HP 1000E   HP 7970E

AMPEX DM 9330 330Mb

ELP II LASER PLOTTER

FIG. 1.— The computer and plotting equipment for hydrographic and cartographic data processing.

2. THE FINGIS AND ITS IMPLEMENTATION
FOR NAUTICAL CHARTING

Development of the FINGIS software

The first version of the FINGIS software was completed in 1985. Since then, extensive efforts have been made to develop the software. At the moment, there are about 25 FINGIS installations in Finland and some in Sweden and in the Netherlands. In February 1987, the Hydrographic Department signed an agreement with the Board of Survey to develop the FINGIS software for the production of nautical charts. According to the experiences gained in using the Department's own system, new features to be implemented into FINGIS were defined. The first version for nautical charting was obtained in January 1988. In 1988, much time has been spent in training and educating the staff in using the FINGIS software and the new MicroVax and Scitex systems. There is still much modification and tuning to be done within the FINGIS software and Scitex procedures, but it is hoped that the system will be in full chart production during the first half of 1989.

The main features of the FINGIS

According to the references (KEISTERI, 1986 and BOARD OF SURVEY, 1987), the structure of the FINGIS software can be divided into three parts: (1) the user interface, (2) the database system and (3) the database management system. In the following, these will be described in more detail.

The user interface

The user sees the system through the user interface. This interface can handle data input and output, queries, interactive examination and modification of data and data transfer into or out of the system. Peripheral devices are also defined via the user interface. The commands and codes can be given by a keyboard or by a menu. The user gets immediate response to the commands he has entered. The user interface of FINGIS is in Finnish or English. For production purposes, the Hydrographic Department has defined appropriate menus and command procedures for each scale of nautical charts. Figure 2 presents an example of a FINGIS menu.

The database

The database file contains spatial data. The database is composed of two separate disc files: the structure file and the chart data file. The structure file cannot be modified after the database has been created.

FIG. 2.— A FINGIS menu used for editing nautical chart databases at the scales 1:40 000-1:50 000.

One database covers a rectangular area and its boundaries are defined by its corner points in a rectangular Cartesian co-ordinate system. Usually, one database contains the content or part of the content of one chart sheet and the database area is equivalent to the chart sheet area. The unit of co-ordinates in the databases is one (terrain) millimeter. This enables the scale of the input and output to be altered freely. However, the database has a default scale which is used as a default for plotting and to give some information about the accuracy of the data in the database.

As used by the Hydrographic Department, one database is normally an area of one sheet of the Basic Topographic Map of Finland (1:20,000). The sheet contains an area of 10 km × 10 km. The default scale for each database is 1:50,000. The databases are in the Gauss-Krüger projection. The nautical charts are in the Mercator projection. Projection transformation into the Mercator projection is computed only for plotting. Mercator co-ordinates will not be stored in databases.

One database is a unit of digitizing or editing of chart data. During interactive work, it is possible to zoom a part of one database onto the screen, or the working area can be defined to contain two or more databases. Also, desired graphical levels can be selected to be in the window. Adjacent databases can be processed simultaneously (e.g. for edge detection).

A database can contain three kinds of geometric entity types (called objects in the FINGIS terminology): (1) a point, (2) a line and (3) a polygon. A point can be an independent point entity (i.e. a symbol, a text point or a special point) or a point can be a line point. The co-ordinates (X, Y, Z) and the code (group, class) of the point are stored in the database. A line can be either a normal line or a special line. A normal line is composed of successive line points. The line points, the code, the interpolation mode and the height value of the normal line are stored into the database. Correspondingly, a special line is composed of successive special points. A polygon is implicitly constructed of lines, i.e. a polygon is composed of a closed chain of lines. A polygon is identified by a text point located inside the polygon area.

The entity types in a database can be grouped into different graphical levels. For instance, one graphical level may contain all hydrographic entity types. The same entity types may also belong to two or more graphical levels. The graphical levels are used for selecting entities for interactive work or for plotting. At the moment, the entity types are divided into some 10 graphical levels. The most important graphical levels in use are: coastlines, depth information, road network, buildings, navigation information, borders, texts and colour masks.

In the database, entity types are divided into different groups and classes. Groups are used for the sake of efficient and easy manipulation of entity types. Each entity type has an unambiguous group and class number. The entity types used for polygon management must be defined into groups for which an area processing has been set on. At the moment, the entity types are divided into some 15 groups. The classification of the entity types can be seen on the menu in Figure 2. The number in the left upper corner of each cell of the menu is the number of the group, and the number in the right upper corner is the number of the class of that entity type.

For efficient geometric access, there is a geometric access index in the database. It is constructed as a square grid over the database area. The addresses of the entities which are located in the area of each index square are stored in the index.

The database management system

The database management system ensures the creating, deleting and copying of databases. It also permits inserting, modifying and deleting data in databases and provides means for searching and reading data from databases. It also takes care that the data is syntactically correct and maintains access indexes. The database management system also maintains the topological part of the databases This means polygon management, automatic relation (e.g. neighbourhood, overlapping and overlay of entities) examination and correction and some spatial data analysis.

It is also possible to define database dictionaries by using the database management system. In these dictionaries, databases and the area limits of databases are described. So, it is possible to locate by the software adjacent databases lying side by side. It is also possible to handle a series of chart sheets as a continuous chart space. For plotting nautical sheets, several databases are needed. These are located by database dictionaries. In Finland, there are five projection zones in use. The FiNGIS database management will perform the special computations needed in connecting databases from different zones.

There are now twelve special definition files for defining how to structure the entity types in the database and how to plot them on charts. These definition files contain e.g. the codes, groups and classes of the entity types, the size and the shape of symbols, text fonts, the width and the type of lines and definitions of menus. These definition files can be created and modified by a text editor or by FINGIS commands.

A special lay-out database will be built up for each sheet of nautical charts. This database will contain all the lay-out information necessary to plot the final sheet. This information will include the area limits of the sheet, the parameters for plotting the frames, seals, titles, publication notes and other texts into the legends and margins of the chart, the places for compass roses, the definitions of enlargements inside the chart area, etc. Once the lay-out database for a chart has been defined, this chart can be reproduced without any extra definitions. The definition of lay-out databases will be done interactively by FINGIS commands.

3. THE NAUTICAL CHART PRODUCTION SYSTEM

The main purpose of the new chart production system is to produce new nautical charts with computer-assisted methods. All the data of nautical charts will be stored into FINGIS databases. The aim is to get the printing films plotted by Scitex without any manual additions or corrections made afterwards on these

films. It is also intended to update these sheets with this system. For new prints and editions, new films will be plotted.

Creation of digital chart data

Chart data for nautical charts is obtained from existing topographic maps, from old nautical sheets, from old hydrographic survey sheets or from new digital hydrographic survey files.

The existing chart data must be digitized into FINGIS databases. This digitizing is done manually by FINGIS. The National Board of Survey also utilize automatic digitizing. They are using a Scitex system for scanning and vectorizing the coastlines of the Basic Topographic Map of Finland. They have also digitized selected road networks and buildings for the Hydrographic Department. This digital information can be obtained directly in FINGIS databases.

The land information is plotted on proof plots at the scale of the hydrographic fair sheets. Then from the hydrographic fair sheets, the depth and fairway information is selected that is needed for nautical charts. This selection is made manually and the selected entities are drawn by a cartographer or a draughtsman on these proof plottings in different colours. Then, the depth and fairway information will be digitized by using the workstations.

In Figure 3, there is an example of these proof plottings. The first plot (3a) contains the data from the Board of Survey with the manually added depth and fairway information. The second plot (3b) contains the same data plotted after digitizing.

New hydrographic surveys produce depth data directly in digital form. This data can be processed into contours or selected soundings, as previously described by the author (KORHONEN, 1983). The aesthetic quality of these outputs is not good enough for nautical charts. That is why a semi-automated system is used. The software for processing hydrographic data does the preliminary sounding selection and contouring. These results are transferred into FINGIS databases by using FINGIS data transfer files. Then a cartographer or a draughtsman selects the final soundings and edits the contours for nautical charts by using the FINGIS editing capabilities.

Editing of chart data

When the data has been stored in the databases, it can be edited by a workstation. The editing is done by the FINGIS commands (e.g. add, delete, modify, move) one entity at a time. It is also possible to manipulate two entities by one command (e.g. join, compare). The editing is controlled by the menu and the cursor, or commands are given directly by the keyboard.

When two adjacent databases are ready, the edge detections can be performed between these databases. This means that it is checked that each line crossing the database limit is continuous on the adjacent database. This process can be done for all entities by a FINGIS command and by using a given tole-
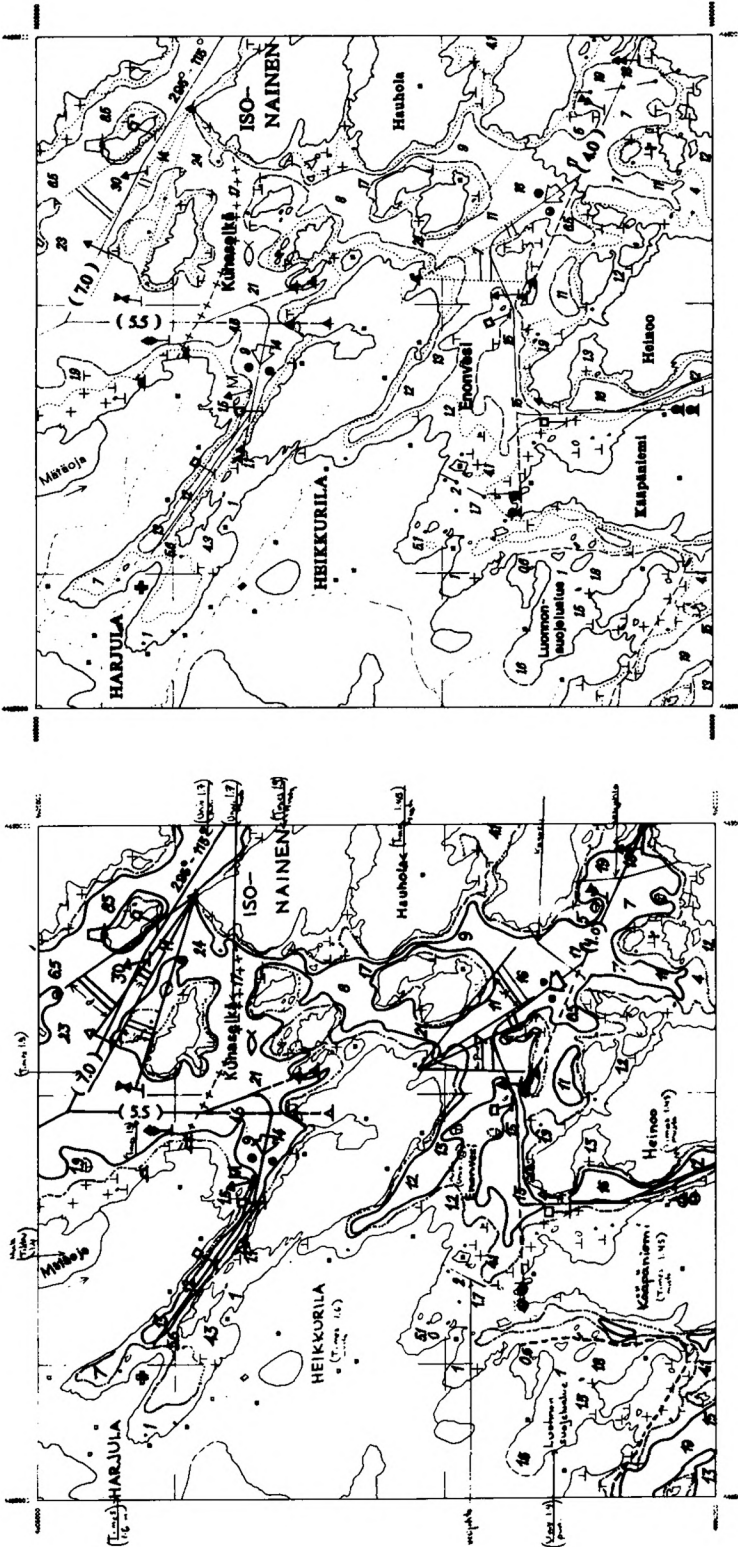
FIG. 3.— Creation of digital chart data.

(3a) Coastlines, roads and buildings plotted from a database. Depth, navigation and text information drawn manually for digitizing.
(3b) The same database plotted after digitizing.

rance, or it can be done interactively entity by entity. For interactive edge detections, two adjacent databases are plotted on the same screen (half of the screen for each database) and edge detections can be done as normal editing.

Area manipulations

Areas and the identification of areas can be created for the whole database as a batch job, or interactively polygon by polygon. After creating the areas, the topology of the areas will be checked. This is done by plotting the nodes and the polygons on the screen or by a plotter. It is possible to plot inadequately defined polygons with different colours. Possible errors in the polygons can be corrected interactively. The maximum number of vertices in one polygon is 10,000. If this limit is exceeded, the polygon must be divided into two polygons by a hidden line.

Figure 4 contains examples of area checking. The first plot (4a) shows the nodes (with addresses and directions) and the polygons. The second plot (4b) contains the hatched areas and the identification points.

Proof plotting

Chart data from FINGIS databases can be plotted directly on the workstation screen or on some of the plotters, or the plotting file can be saved as a meta file on a disc. The meta file contains only the information needed for plotting a chart. With this kind of meta file, it is easy and fast to combine several charts together. For instance, meta files are used when plotting the lines, texts and colour masks (as screened) on the same plot. For proof plotting, all necessary definitions are done within the FINGIS software and database.

It is possible to plot proof plottings whenever needed. Normally, proof plottings are made for each database when it is supposed to be ready. Then line, symbol and text plottings as well as colour mask plottings are made. In Figures 3 and 4 there are some examples of these proof plottings.

Final plotting

When producing a final nautical sheet for printing, five films are plotted by the Scitex plotter. This is done in the following steps: first, three meta files are computed from FINGIS databases (one for lines and symbols, one for texts and one for colour masks). Then these meta files are converted into SIF files (Standard Interchange Format of the Scitex). These SIF files are transferred (by a mag-tape or via the direct link) into the Scitex system and converted into Scitex DIGIT (vector) files by the Scitex software. These DIGIT files are converted into Scitex RAS (raster) files, which can be combined to Scitex PLOT files. There will be one PLOT file for each film to be plotted (black, navigation green, navigation red, green gray for land tint and yellow for shallow water tint). These PLOT files will be plotted with the Scitex ELP II plotter on films. The films should be ready for processing and copying on the printing plates. Figures 5 and 6 show some
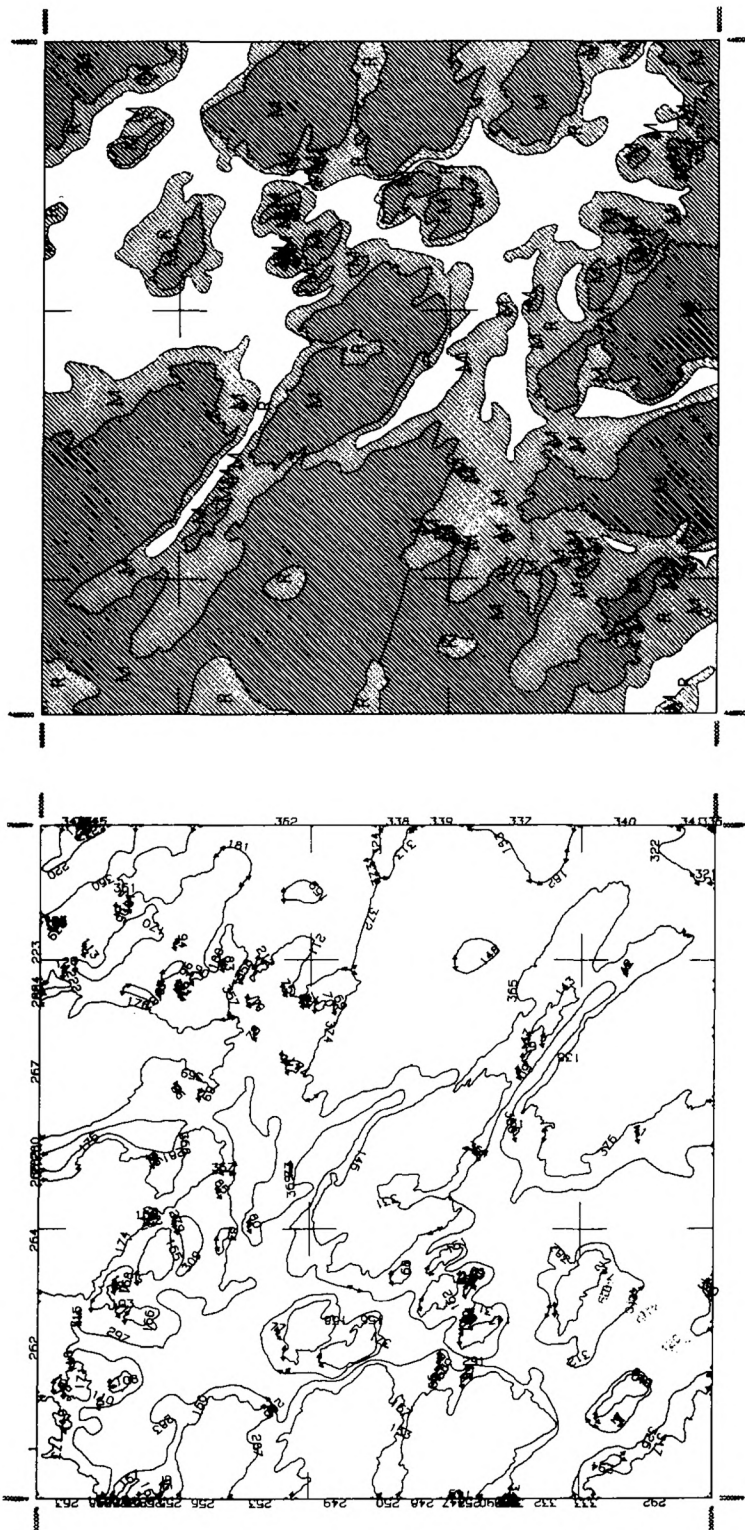
FIG. 4. — Proof plottings for area checking.
(4a) Polygon lines, nodes, addresses and directions of lines plotted.
(4b) Areas hatched and marked.

FIG. 5.— Examples of final Scitex plottings from a FINGIS database.
(5a) Black colour film   (lines, symbols, texts, frames)
(5b) Green colour film   (land tint)
(5c) Yellow colour film   (shallow water tint)
(5d) Red colour film   (navigation red)
(5e) Green colour film   (navigation green)
(5f) One colour film   (all elements).

FIG. 6.— An example of a sheet of a nautical chart plotted in one colour by Scitex.

examples of the films plotted for five colour and for one colour charts.

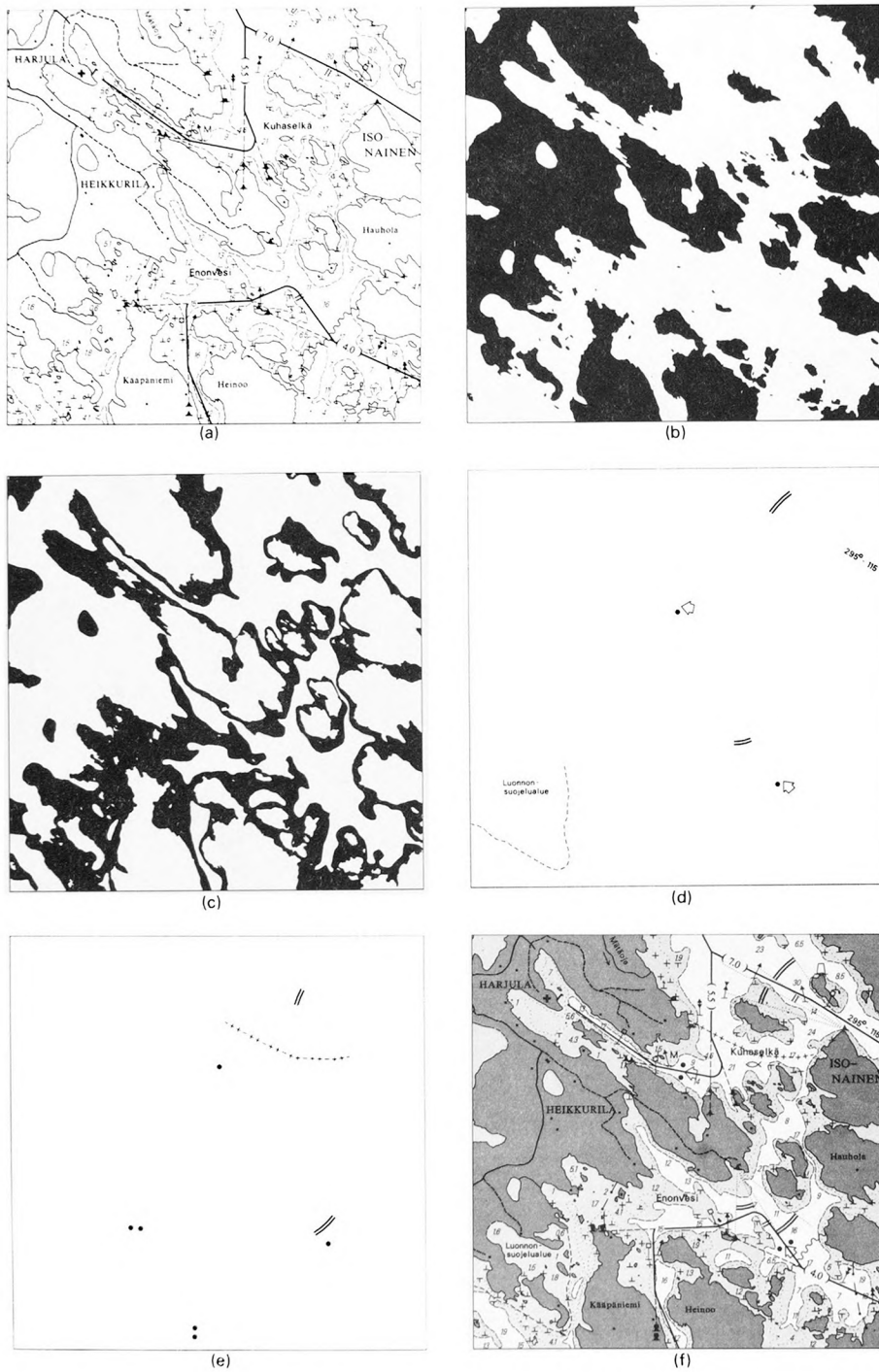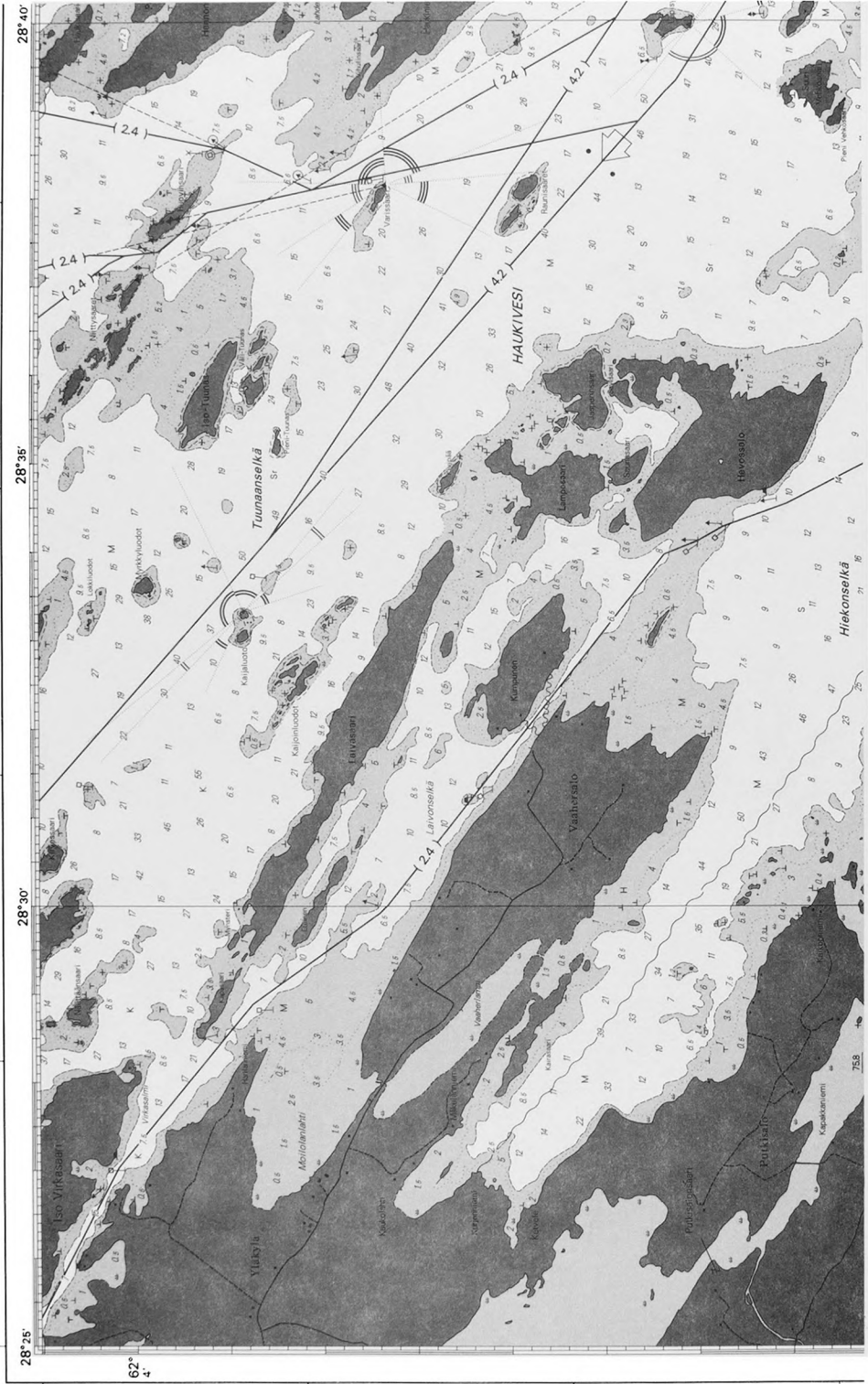For final plotting by the Scitex plotter, the necessary definition files are created in the Scitex system. These are the screenlib file for area fillings (screened masks) and the fontlib file for line widths and colours. The Scitex processing is controlled by command procedures. The plotting of all the five colour films can be done by one command given on the Scitex console.

It is also intended to plot enlargements inside the main chart area. The enlargements are in different databases. Different meta files will be plotted for the main chart and the enlargements. The combination of these files will be done by the Scitex software so that the enlargement data overlays the main chart data.

4. DISCUSSION

General remarks

The implementation work has been more laborious and more time consuming than estimated. There have been many errors and shortcomings in the FINGIS software. By now most of them have been corrected. The user interface of the software is quite inconsistent and needs still more programming to be user friendly, clear and easy to use. The use of some simple operations is complicated. The overall documentation of the FINGIS software is good, but there have been delays in delivering the documentation of the modifications which have been made for nautical charts.

Capacity questions

The 10 km × 10 km square area for databases seems to be quite adequate. This area is suitable for interactive editing. Normally, there is not too much information in one database to prevent a fast and clear picture appearing on the screen. If there is too much information in one database, it is possible to utilize the windowing and selection capabilities of FINGIS.

The average amount of data in one database is approximately 2500 entities. This data takes approx. 0.75 Mb disc memory. The average time for extracting and plotting one database is approx. 3 minutes. For a normal sheet of a nautical chart (70 cm × 100 cm), 18 databases are needed and, for a sheet of a yachting chart (40 cm × 60 cm), 6 databases are needed. The disc space requirement and processing times are correspondingly 18 and 6 times higher. It seems that up to three workstations can be operated simultaneously in one Micro-Vax 3600 computer with an acceptable response time.

The plotting of the five films for printing a normal nautical sheet usually takes about 50 minutes of computer cpu-time and nine and a half hours of Scitex processing time. The corresponding times for a sheet of a yachting chart are 18 minutes of computer cpu-time and 4 hours and 25 minutes of Scitex processing

time. Processing can be performed as unattended batch jobs.

Neither the MicroVax nor the Scitex processing procedures are optimized as yet. It is hoped that these times can be reduced to some extent.

The sizes of the meta and SIF files of an average nautical sheet are 30 Mb and 25 Mb, and of an average yachting chart sheet 11 Mb and 9 Mb. These files are temporary and needed only during the computing of the final plotting and when transferring the plotting data into the Scitex system.

The Scitex plotting time is 25 minutes (30 lines per mm) for a nautical chart sheet or 20 minutes (50 lines per mm) for a yachting chart sheet per film. The plotting time is constant, regardless of the amount of data on the film, but it is a function of the size and the resolution of the plotting.

According to the times given above, it will be possible to produce new films annually for new prints or editions of all the Finnish nautical charts.

Data management

All the data are stored in one node of the LAVC. All data discs are connected with the main MicroVax 3600. This computer runs as a file server. The backup and other disc space utilities must be operated in one computer only.

In daytime, delays are sometimes caused by heavy disc use in the main MicroVax 3600 when there are many users using the same disc units. An attempt has been made to speed up processing by utilizing the local discs of the Vax-stations for storing some definition files (e.g. text fonts), but this has not yet succeeded. At the moment, the MicroVax system parameter and the FINGIS parameter tunings are probably not the best ones.

The sheets of the nautical charts overlap to some extent and the same cartographic entities may belong to several sheets. But the entities are stored only once. This is possible, because the databases lie without any overlapping or gaps between neighbouring databases. There are two exceptions to this rule. At the moment it seems that two special databases are required for each sheet, one for the text element and one for the fairway information. The reason for this is that slightly different text and navigation lay-outs are needed for different nautical chart sheets.

The history log file system (for storing the modifications of the entities in the database) has not yet been implemented.

Projections

The Gauss-Krüger projection was selected as the database projection for the reason that almost all data available to the Hydrographic Department is in that projection. The Basic Topographic Map of Finland and all hydrographic surveys are in the Gauss-Krüger projection. The nautical charts are in the Mercator projection. When computing the plotting code for the sheet of a nautical chart, the FINGIS software will transform the co-ordinates of all entities to be plotted into

the Mercator projection. Thus Mercator co-ordinates will not be stored in databases.

When data from charts in the Mercator projection (i.e. old nautical sheets) is digitized, the digitized co-ordinates must first be transformed into the Gauss-Krüger projection. The co-ordinate transformation is done by the FINGIS when copying the database into another database. At the moment, only a limited amount of experience exists about these transformations.

Lay-out

The definitions of the symbols have been more laborious than was expected. Some features of certain symbols have been coded into the software. This is a poor solution if the symbol must be modified.

At present, the FINGIS software is not ready for full processing of lay-out databases. Only some information can be defined, needed for describing the lay-out. The interactive defining of the lay-out databases has not yet been implemented. The total lay-out processing should be in operation during 1989. Todate, no attempts have been made to plot enlargements inside the chart area.

So far, the system for producing national nautical charts has been defined. The system for producing international (INT) charts must also be defined. For this, the definition and parameter files must be modified. It is intended to copy the contents of the national nautical chart databases into the INT chart databases. These INT chart databases will then be edited separately from the national chart databases.

Plotting

When plotting a sheet of a normal nautical chart (70 cm × 100 cm), 30 lines per mm resolution can be used and when plotting a sheet of a yachting chart (40 cm × 60 cm), the resolution of 50 lines per mm can be used. This resolution of the Scitex laser plotter is good enough. It seems that even when using the lower resolution (30 lines per mm), all symbols and text fonts can be plotted as clear and sharp figures on film. When using very thin fonts, there may be problems in the area fill operations of the Scitex.

Problems occur when using a pen plotter for area checking. The hatching of the areas by lines is too time consuming and the quality is not very good. It is hoped that this problem will be solved when an electrostatic plotter is obtained.

Problems with the disc space exist when using meta and SIF files. The developers of FINGIS are studying the possibility of using Scitex DIGIT files directly instead of SIF files. This would decrease the disc space requirement in MicroVax by approximately 50 per cent and speed up the processing time of Scitex by approximately 25 per cent.

Software quality

When implementing FINGIS, it was decided to do as much as possible of the data manipulations with the FINGIS software. The special capabilities of different peripheral equipment are not used. The reason for this is that it is desirable to get as similar a chart or picture as possible when using different plotting systems or screens. This is of course not the optimal way (for efficiency or quality) to use all the peripheral systems. Exceptions to this rule are the hardware area fillings with different plotters and screens and the use of the Scitex software to mask off the lines and symbols that lie under the texts of a chart.

FINGIS supports the Tektronix screen capabilities more efficiently than the Vaxstation screen capabilities. When using the Vaxstations, problems occur in area fillings and local zoom. The FINGIS driver cannot utilize the Vaxstation software in the best possible way.

Separation of the software code and definition data has not fully succeeded because some plotting definitions (for borders and light sectors of lights) are in the program code, not in the parameter files.

The overall reliability of the software has been good. The functions which are in production use are reliable and running correctly.

Data transfer

FINGIS has a sequential data transfer format. The software can read and write data from or into files written according to this format. Thus it is easy to make links between the programs for processing hydrographic survey data and FINGIS databases.

An attempt has been made to convert some old nautical chart databases into FINGIS databases using the transfer file. There are problems because the old database has no area processing capabilities. There are also extra records in the data, which were omitted by the old software, but which cause errors during transfers into the FINGIS databases.

The transfer of data from digital hydrographic databases into FINGIS databases has also been tried. There have been problems according to differing definitions of the reference point of the depth values between these two databases.

An Oracle database for lighthouses, buoys and other navigational safety equipment and fairway information is being built. This database will be continuously updated. A software link will be made between the FINGIS databases and the Oracle database. During the first phase, this link will be implemented as a transfer file between these databases. The updated navigation information will be transferred from the Oracle database into the FINGIS databases for each new print or edition of nautical charts. The necessary cartographic editing will be done by FINGIS.

Future development

In addition to the developments mentioned above, there are plans to add new features into the software, e.g. the possibility to plot Decca lattices or certain special grids on the charts.

It is planned to develop an interface to FINGIS for transferring data in standard format for electronic charts. The FINGIS database management system can create the necessary topology for delivering data into sophisticated transfer formats (e.g. IHO-87 or MACDIF formats). However, this action is being held until there is enough data in the databases and until there is a general acceptance of one of the formats before implementing it into FINGIS.

The FINGIS system and the use of Scitex plotter enable the Hydrographic Department to change the printing of nautical charts into a four colour printing. The Scitex software can do the colour separation into black, magenta, cyan and yellow. This possibility is being studied.

Other use of the FINGIS software

This paper describes the use of FINGIS software for the production of nautical charts. The FINGIS software has also been used for some other purposes, e.g. for plotting fairway charts, for plotting hydrographic survey sheets, etc. Further, it is possible to plot index charts by using FINGIS database dictionaries. FINGIS and Scitex have been used to plot text files on films. FINGIS device drivers have also been used in the Hydrographic Department's software for controlling the graphical peripheral devices. However, only a fraction of the capabilities of FINGIS software has been used. In the references (KEISTERI, 1986 and BOARD OF SURVEY, 1987), there is more information about FINGIS software and its features for other spatial data manipulations.

5. CONCLUSIONS

The system described in this paper has not yet been in full production use. The preliminary tests indicate that this system will suit the needs of the Hydrographic Department and that it can perform the tasks necessary in nautical charting. It seems also that the estimated quality and capacity level can be achieved. There is still much work left in tuning the system for continuous production use. The updating of nautical charts has not yet been tested with this system. At the moment, no real estimates of the costs of the use of this system are available. Moreover, the present period of changing production from one system to another is very laborious for the personnel because both the old manual methods and the new system must be used simultaneously. However, during the next few years, the main problem will be to get the old data into digital form, for further processing by this system.

A paper describing more about the Finnish Hydrographic Department's chart production system will be presented during the 14th International Cartographic Conference in Budapest in August 1989.

References

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[2] KEISTERI, T. (1986): FINGIS Software and Data Manipulation. Auto Carto London, London, England, September 14-19, 1986.

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