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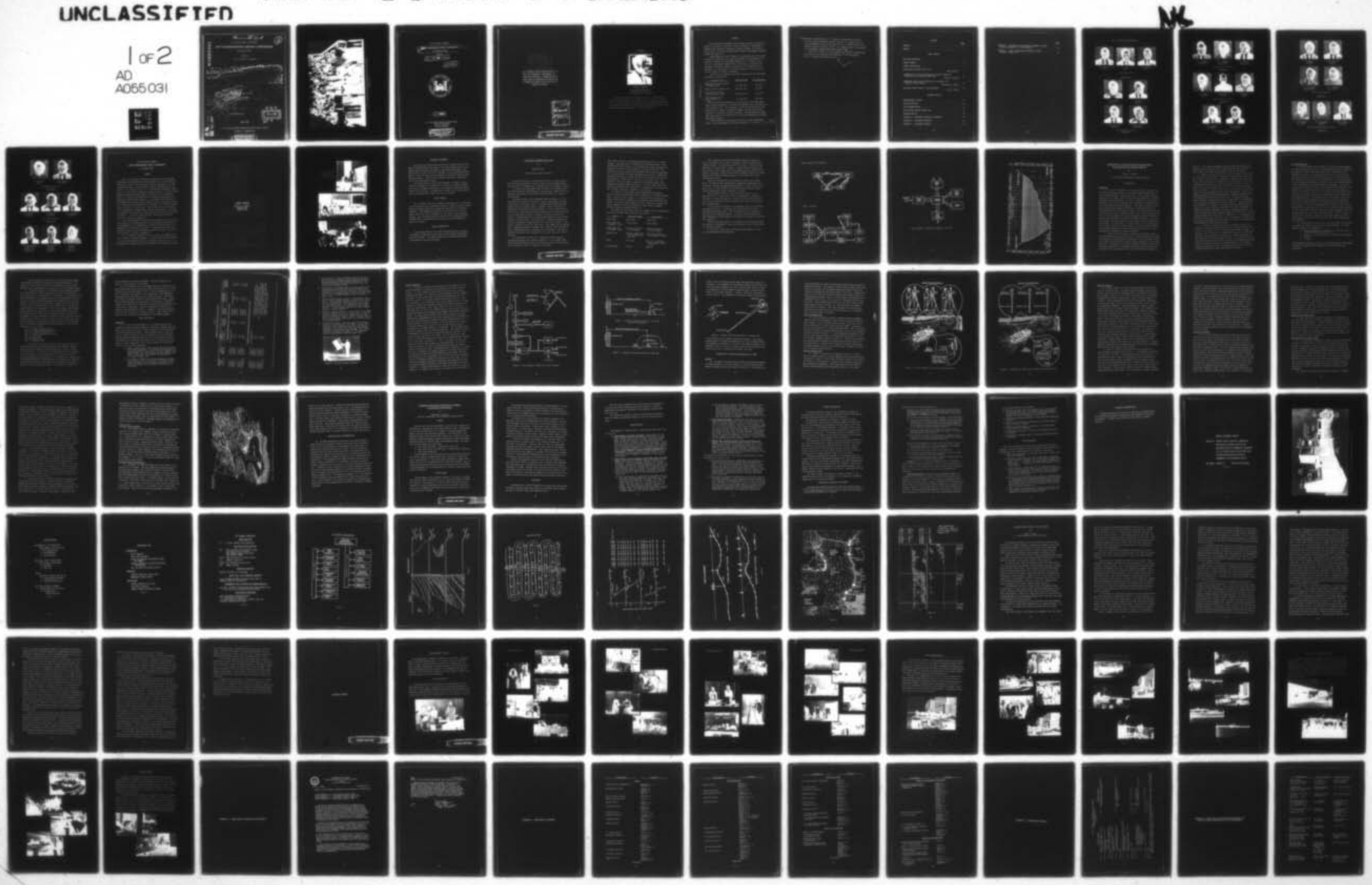

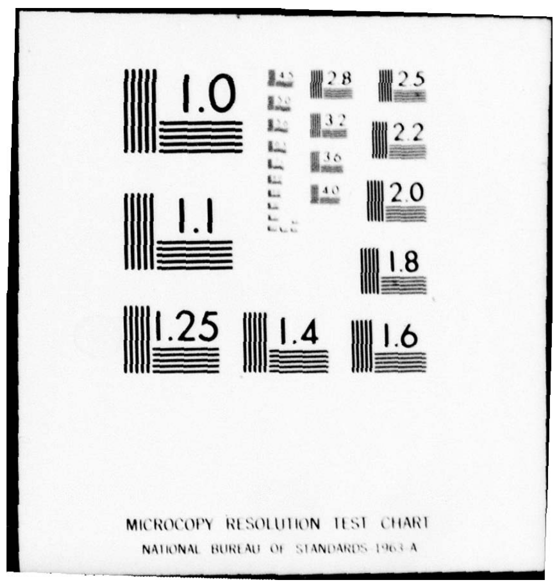
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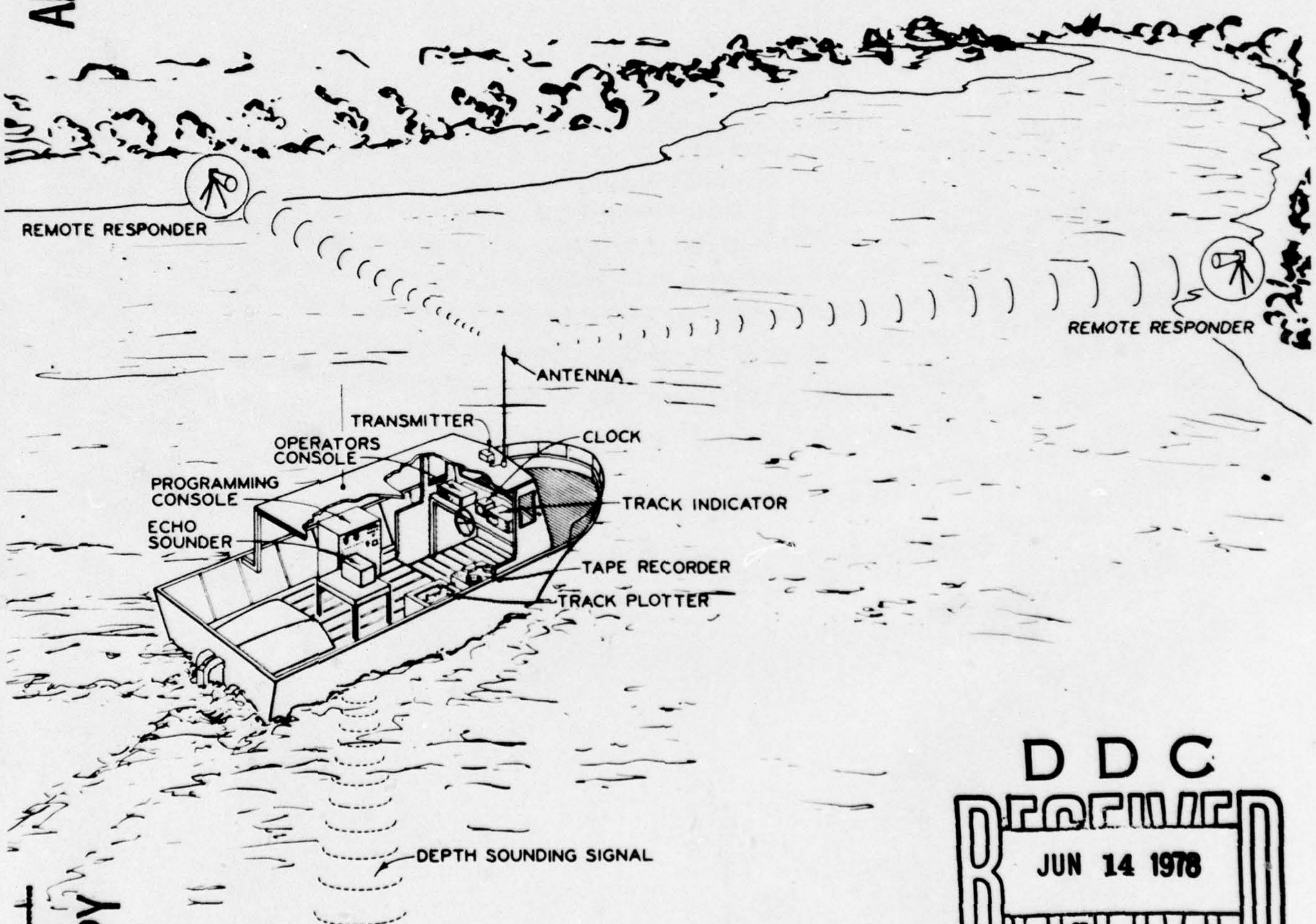
U. S. Army Corps of Engineers

FIFTH HYDROGRAPHIC SURVEY CONFERENCE

8-9 November 1977

Edited by

E. D. Hart and G. C. Downing



March 1978

U. S. Army Engineer Waterways Experiment Station
CORPS OF ENGINEERS
Vicksburg, Mississippi

FIFTH U. S. ARMY CORPS OF ENGINEERS HYDROGRAPHIC SURVEY CONFERENCE
Norfolk, Virginia
8-9 November 1977

U. S. Army Corps of Engineers

6 [redacted] HYDROGRAPHIC SURVEY CONFERENCE (5th)

8 - 9 November 1977,

Edited by

10 E. D. Hart [redacted] G. C. Downing

12 103p.

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U. S. Army Engineer Waterways Experiment Station
CORPS OF ENGINEERS
Vicksburg, Mississippi

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In Memory

Frank W. Straub

Chief, Maintenance Branch
Kansas City District
U. S. Army Corps of Engineers

Hydrographic Surveying personnel of the U. S. Army Corps of Engineers were saddened at the passing of Mr. Straub. He had spent most of his engineering career with the Kansas City District Office. Mr. Straub passed away on 8 November while attending the Corps' Fifth Hydrographic Survey Conference in Norfolk, Virginia.

FOREWORD

The Integrated Hydrographic Survey Systems study was initiated in 1971 as a work unit of the Office, Chief of Engineers' Improvement of Operation and Maintenance Techniques research program. The objective of the study is to ensure effective and efficient hydrographic surveying systems for Corps use.

Accomplishments to date include (a) a literature search for state-of-the-art information, (b) a continuing canvass of manufacturers for available equipment and development programs, (c) a survey of Corps Districts to determine responsibilities and needs, (d) initiation of equipment development programs including District evaluation of the equipment, (e) development of a training program for technicians, and (f) the holding of biennial conferences.

Four previous conferences have been conducted and the proceedings published as listed below:

Conference Site	Conference Date	Publishing Date
Waterways Experiment Station, Vicksburg, Miss.	9-11 May 1972	Oct 1972
Mobile District, Mobile, Ala.	30-31 May 1973	Oct 1973
San Francisco District, San Francisco, Calif.	21-22 May 1974	Dec 1974
New Orleans District, New Orleans, La.	5-6 Nov 1975	Mar 1976

This publication summarizes the proceedings of the Fifth Hydrographic Survey Conference at the OMNI International Hotel, Norfolk, Va., on 8-9 November 1977. The conference, as were the previous four, was conducted to encourage a continuing exchange of ideas, methods, and experiences of District surveying personnel. The experience and knowledge thus gained will be beneficial to the Corps hydrographic surveying improvement program.

The conference was sponsored by the Office, Chief of Engineers (OCE). These proceedings were compiled by Messrs. E. D. Hart, Hydraulics Laboratory, and G. C. Downing, Instrumentation Services Division, under the general supervision of Mr. F. P. Hanes, Chief of the Instrumentation Services Division, Mr. E. B. Pickett, Chief of the Hydraulic Analysis Division, and Mr. H. B. Simmons, Chief of the Hydraulics Laboratory, Waterways Experiment Station (WES).

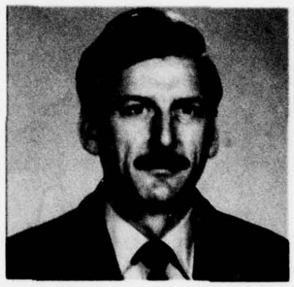
COL John L. Cannon, CE, was Commander and Director of WES during the period of the conference and preparation of the proceedings. Mr. F. R. Brown was Technical Director.

ABSTRACT

CONTENTS

CORPS CONFERENCE REPRESENTATIVES

M. Millard
OCE



D. Hart
WES

G. Downing
WES

Coordinating Group

W. F. Muszak
New York

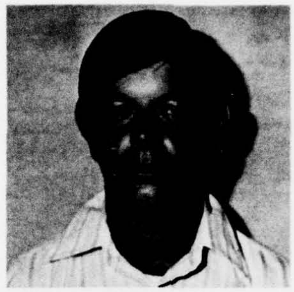
W. Auter
Baltimore

R. A. Pruhs
Norfolk

H. R. Spies
Philadelphia

North Atlantic Division

O. J. McCoy
Wilmington



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J. Pruett
Jacksonville

South Atlantic Division

B. J. Adams
Alaska

N. H. West
Portland

H. Maresh
Seattle

North Pacific Division

H. Anderson
Los Angeles

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San Francisco

South Pacific Division

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J. L. Crittenden
Rock Island

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St. Paul

North Central Division

G. N. Brown
St. Louis

A. L. Wilkerson
Memphis

R. J. Sykes
Vicksburg

Lower Mississippi Valley Division

H. Hartwell
Tulsa

F. B. Morrow
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Huntington

R. R. Applegate
Huntington

Ohio River Division

M. Vanhaverbeke
Kansas City
Missouri River
Division

R. Hamilton
Waltham
New England
Division

V. Kalino
Hawaii
Pacific Ocean
Division

U. S. Army Corps of Engineers

FIFTH HYDROGRAPHIC SURVEY CONFERENCE

8-9 November 1977

GENERAL

The U. S. Army Corps of Engineers conducted its Fifth National Hydrographic Survey Conference on 8-9 November 1977. The Norfolk District acted as host to the conference which was conducted in the OMNI International Hotel. Corps attendees included representatives of 30 District and 3 Division offices, U. S. Army Engineer Topographic Laboratory, U. S. Army Coastal Engineering Research Center, U. S. Army Engineer Waterways Experiment Station (WES), and Office, Chief of Engineers. Other U. S. agencies represented were the National Oceanographic and Atmospheric Administration (NOAA), U. S. Geological Survey, Bureau of Land Management, Tennessee Valley Authority, Naval Oceanographic Office, U. S. Naval Explosive Ordnance Disposal Facility, U. S. Defense Mapping Center, and the U. S. Coast Guard. Also present were representatives of the Governments of Canada, Great Britain, and Venezuela. A memorandum (Appendix A) announcing the conference was issued in September 1977, by the WES. A list of the 146 Government (98 Corps) personnel who attended is included as Appendix B.

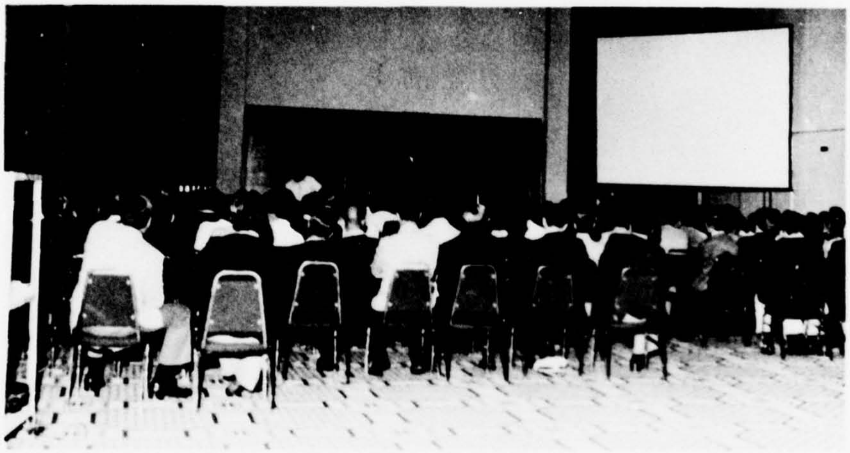
The two-day conference consisted of the presentation of four technical papers by Government employees and the display and demonstration of hydrographic survey equipment by 31 private firms and a tour of the NOAA Atlantic Marine Center in Norfolk. A business meeting was conducted by Corps and other Government attendees on the 9th. The conference schedule is included as Appendix C.

Mr. M. Millard, representative of the Office, Chief of Engineers (OCE), acted as Conference Chairman. Mr. Roger Pruhs and other employees of the Norfolk District acted as coordinators and hosts. Mr. A. L. Wilkerson of the Memphis District was chairman of the technical session.

FORMAL SESSION

Chairman A. L. Wilkerson
Memphis District
8 November 1977

FORMAL SESSION
8 NOVEMBER 1977
PROVIDENCE HALL



WELCOMING STATEMENTS

The opening day formal session was held in Providence Hall of the OMNI International Hotel (see page 4). Mr. Zane Goodwin, Chief of the Norfolk District Engineering Division, welcomed the attendees to the Norfolk District and to the city of Norfolk. He was impressed with the manner in which the Corps and other agencies continued to improve their surveying methods. He felt this conference would play a significant role in this improvement program.

The Norfolk District, with limited manpower, is able to utilize electronic equipment in surveying over 700 miles of navigable channel. He hoped that information obtained at the conference would help them to improve this capability. Attendees were invited to use District facilities as necessary and to enjoy their stay in Norfolk.

OPENING REMARKS

Mr. M. Millard, OCE, also welcomed the attendees to the conference. He reviewed briefly the concentrated program to improve the Corps' hydrographic surveying capabilities through the utilization of electronic equipment. This program was initiated in 1959 and since that time almost every District has automated, to some degree, their surveying systems. This conference should be utilized to the maximum degree to determine what is available and to ensure that private industry is aware of our needs.

FORMAL PRESENTATIONS

The primary purpose of the formal presentations was to promote an exchange of experience in the Corps and other agency hydrographic surveying programs. The papers discussed two new surveying systems, system mobility and data processing.

TRAILERABLE AUTOMATED SURVEY BOAT

by

Donald Thrower

Survey Section, Mobile District

During the past year in the Mobile District, our Survey Section has been working with WES in testing a small boat data logger device, which consists of a Morgan D-81, interfaced with a Tellurometer CA1000-D.

The Morgan D-81 hydrographic data processor is an advanced portable data collection system designed to automatically sample and record digitized water depth, boat position, and time-of-day on a standard cassette tape.

The sampling rate can be programmed from the keyboard to occur automatically at specified intervals or manual sampling may be accomplished from a front panel switch. A calculatorlike numeric-function keyboard and the displays provide a reliable, easy-to-use method of data entry for setting up mission parameters. A set of eight switches are used for controlling the various operating modes of the system, and a set of eight LED's inform the operator of various conditions and statuses. Recorded data can be reviewed and displayed or can be transmitted to a remote device. The Morgan D-81 is especially designed to be small, lightweight (approximately 15 lb), and with low power. This makes it especially useful for small boats. The Morgan D-81 is supplied with a lightweight 200-kHz transducer to be operated "over the side" so that a permanent mounting or brackets are not necessary. All that is needed for operation of the Morgan D-81 is a power source of 12 VDC at 36 watts.

The Tellurometer CA1000-D is a standard electronic distance-measuring instrument with a dynamic capability. In the Dynamic Mode this distance-measuring system can continuously monitor a moving vessel with an accuracy of ± 2 ft at ranges up to 15 miles.

The vessel's position is continuously presented in feet on a digital display. These data can be interfaced with a digital printer. This single-range system consists of two instruments, termed the Master and the Remote, which are tripod mounted at each end of the line to be measured, the slope distance being obtained from the Master instrument. In a situation where the Master and Remote units are not intervisible, continuous monitoring of signal strength and, therefore, direction can be observed by a large meter on the face of the Master unit. The CA1000-D is fast and simple to operate with continuous duplex voice communication between Master and Remote. The size, weight (8-1/2 lb), and power consumption have been kept to a minimum due to the exclusive use of modern, solid-state components in the design.

The small boat data logger system (Morgan D-81-Tellurometer CA1000-D) collects hydrographic data electronically on standard cassette tapes. With an acoustic coupler the survey party has the ability to transmit field data by telephone to the Automatic Data Processing (ADP) Center. The data are then accessed to a host computer for various uses such as computer plotting of hydrographic range section, dredging quantity estimates, hydraulic design, etc.

The small boat data logger system is compared with the conventional tag line and Raytheon depth-recording system below.

Item	D-81 Data Logger	Conventional
Survey party	4-man party	5-man party
500-ft range and overbanks - field	8 hr/16 ranges	8 hr/8 ranges
500-ft range and overbanks - office	Reduced and plotted 2 hr/16 ranges	Reduced and plotted 16 hr/16 ranges
Turnover time	Transmits immediately with immediate data reduction	Field notes mailed in - data reduced in office
Safety	No tag line	Tag line - lightning, barge traffic, objects in water
Distance/range	±7 miles	±1000 ft

After using the small boat data logger system for 8 months on one of our primary river projects (Tenn-Tom) we were confronted with several problems. The main problem with this system is track loss when operating in certain areas or locales. Around locks and dams the distance track is lost because of the large amount of wave reflection from concrete structures. There have also been problems of track loss around electric power lines and when operating in the vicinity of a radio transmitting station.

During the same period, other companies' systems were investigated. The "Miniran Ran" manufactured by Navigation Management, Inc., of Anthony, Florida, was demonstrated at Walter F. George Lock and Dam. Track loss, the same problem, was encountered when operating within an area approximately 1000 ft upstream of the dam.

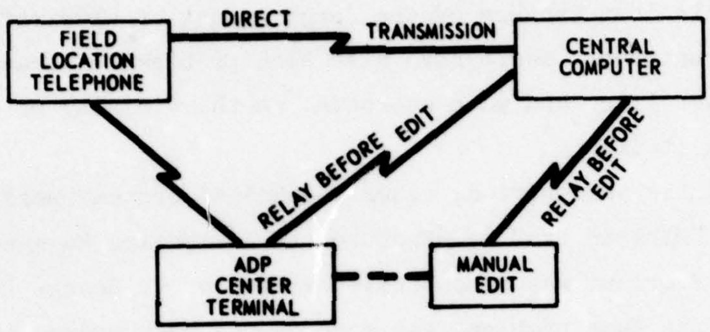
Decca Surveys of Houston, Texas, was under contract to the Mobile District to survey the reservoir area immediately upstream of the Walter F. George Lock and Dam. Observed by Survey Section personnel, the Decca Autocarta System accomplished the survey without track loss or malfunction.

The Decca Autocarta System was recommended highly by both Memphis and Oregon Districts. In February 1976 we purchased a 23-ft all-aluminum utility MonArk Boat. Then in February 1977 we purchased the Short Range Decca Autocarta System. The Decca Autocarta System has full hydrographic survey capability including data logging for accessing host computers.

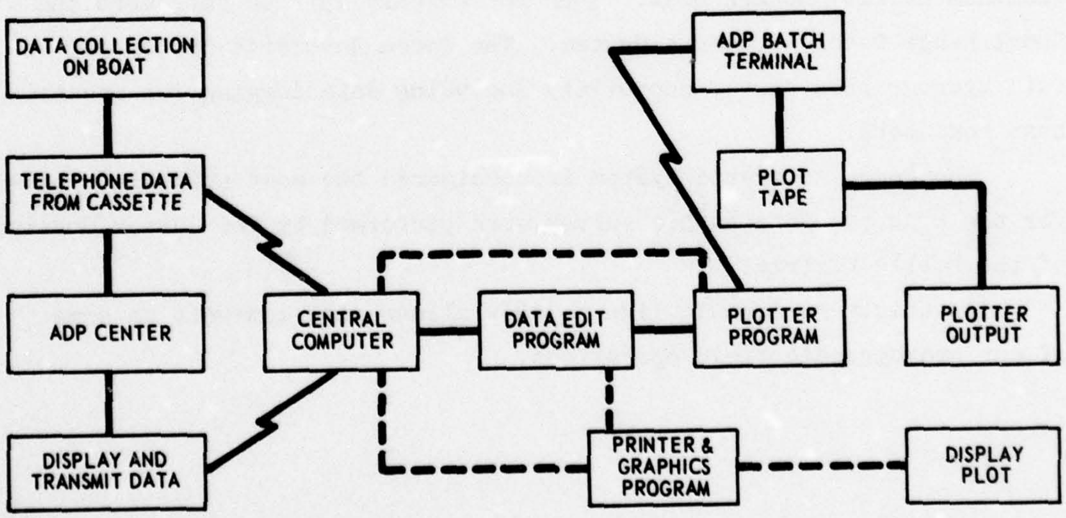
The Decca Autocarta System is considered the most suitable system for the type of hydrographic survey work performed by the Survey Section of the Mobile District.

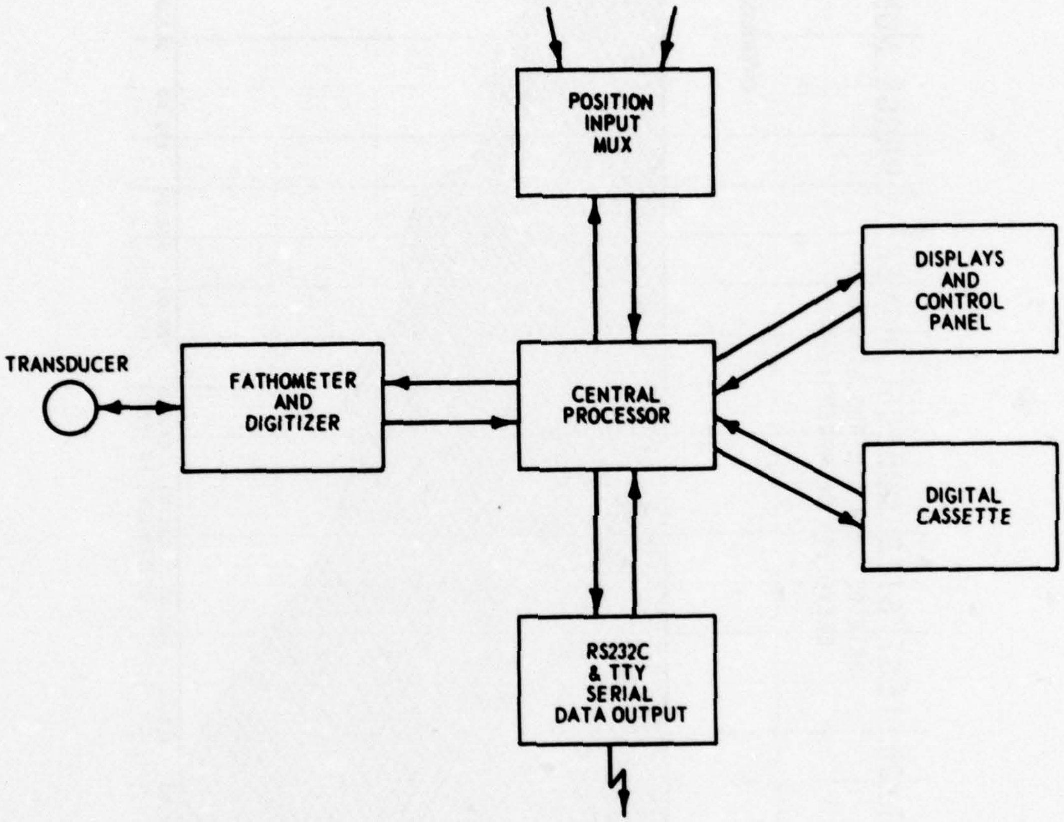
At this time I would like to show slides with comments on some of our hydrographic field operations.

SLIDE - Raw Data Transmission

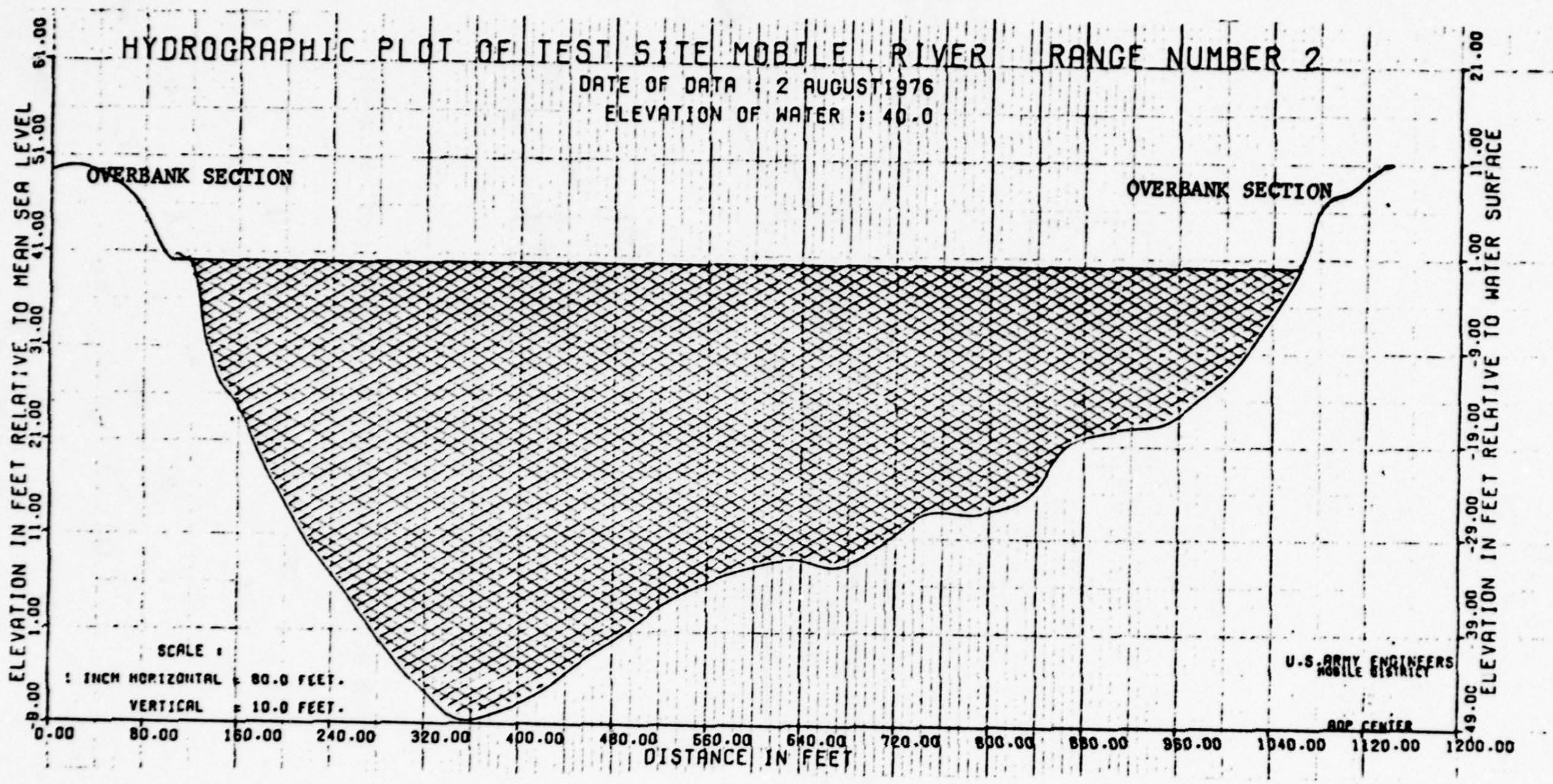


SLIDE - Overview





Block diagram of functional elements of the D-81



HYDROGRAPHIC PLOT OF TEST SITE MOBILE RIVER RANGE NUMBER 2
DATE OF DATA : 2 AUGUST1976
ELEVATION OF WATER : 40.0
OVERBANK SECTION
OVERBANK SECTION
SCALE :
1 INCH HORIZONTAL = 80.0 FEET.
VERTICAL = 10.0 FEET.
U.S.ARMY ENGINEERS
MOBILE DISTRICT
ADP CENTER
ELEVATION IN FEET RELATIVE TO MEAN SEA LEVEL
-9.00
1.00
11.00
21.00
31.00
41.00
51.00
61.00
ELEVATION IN FEET RELATIVE TO WATER SURFACE
49.00
-39.00
-29.00
-19.00
-9.00
1.00
11.00
21.00
DISTANCE IN FEET
0.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
640.00
720.00
800.00
880.00
960.00
1040.00
1120.00
1200.00

DEMONSTRATION OF PASSIVE REFLECTOR NAVIGATION SYSTEM FOR DREDGING AND BUOY TENDING OPERATIONS

by

George C. Downing

U. S. Army Engineer Waterways Experiment Station

INTRODUCTION

Background

1. The Corps of Engineers is heavily involved in a number of inland marine operations related to the construction and maintenance of our national waterways. This entails work in rivers, canals, harbors, reservoirs, and estuaries under widely differing conditions of climate, topography, and urban factors. In order to maintain an efficient and responsive service, Corps management has encouraged the development and use of up-to-date methods and equipment. This paper describes an evaluation study directed toward improving the techniques available for positioning marine vessels such as dredges. The study reported here was inititated by the Corps of Engineers with recent interest and participation by the Coast Guard (CG), since both organizations have recognized the need for improvements in marine positioning techniques. The CG interest relates to their requirement for accurate position information in buoy tending. The objective of the Corps' phase of this investigation was to study the use of a passive reflector positioning system (PRANS) in simulated dredge service and to evaluate its potential as a lower operating cost alternate to existing techniques.

2. Within the past few years, electronic positioning systems of several different types have been tried on dredges operated by the Corps. Two electronic distance-measuring systems are in use on dredges working on the East Coast and there are three acoustic navigators in use on the West Coast. In addition, the Corps has numerous electronic positioning systems on survey boats. Electronic positioning systems currently in use perform well but require active shore units which are complex and

expensive. The acoustic navigators operate without the need for shore stations but have limitations due to drift and they cannot operate in river channels which have moving sediment layers on the bottom.

3. Expense of the shore units of all the microwave active responder positioning systems makes it necessary to man the shore stations in most instances to avoid theft or vandalism. Expense of the shore units of the most accurate active responder positioning systems is also high (approximately $15K/unit) such that the number practical in use is restricted to the bare minimum, which in turn limits operating freedom. Thus, as a dredge or survey boat moves to a new location it is necessary to move the shore responders and the shore crew members. Active responder systems also require power which is supplied by batteries that are recharged and replaced on a daily basis. In normal operation, active responder systems require setup of shore units at the beginning of each day and disassembly at the end of each day. In the event that 24-hr operation is required, two or three shifts of personnel will be needed and, in many situations, exposure of the shore crew members to conditions which are unacceptable in modern employment practices. Another situation where active responder systems are limited is in guiding a hopper dredge from a shoal area to a dump area. It is impractical to move the shore stations each time a trip to the dump is to be made and the distance from shoal to dump is usually too long to be covered by the limited number of shore units available.

4. A study to investigate the use of a PRANS on dredges was proposed to the Corps by Associated Controls and Communications, Inc. (ACCI), as a potential method of improving operational efficiency. Objectives of the study were to (a) demonstrate the use of a PRANS under conditions which simulated the operation of a hopper dredge and (b) gain experience in the use of such a system. It was expected that the experience so gained would improve the design of a subsequent prototype system if additional development appeared warranted. The proposed study was considered to have a considerable merit and the field test program reported in this paper was therefore initiated.

Field demonstration

5. The New England Division (NED) was contacted by WES regarding the PRANS project and assistance in conducting the program was requested. NED agreed to provide a boat and operator and to assist with their knowledge of the area. This support enabled the site of the test program to be located in the Boston Harbor area, which greatly assisted the installation and checkout for the demonstration. The area selected for the simulated dredge maneuvers was out of the main shipping channels of the Boston Harbor so that interference was minimized. Islands surrounding the area provided sites for the shore mounted reflectors. The availability of Corps survey data on the islands was also taken into account in selecting the sites. Five reflectors were installed by ACCI: three were on surveyed sites at Nixes Mate Island, Lovell Island, and an unnamed rock east of Bug Light; two were on unsurveyed sites, with one of these being on Peddocks Island and the other on a navigation light west of Peddocks Island. The unsurveyed reflectors were originally intended to be used to demonstrate U-turn maneuvers only and the availability of survey data was not used as a criteria in site selection. As things developed, unseasonal storms and vandalism damaged two of the surveyed reflectors late in the preparation stage. Due to the need to avoid extensive schedule slippage, it was deemed expedient to shift to the unsurveyed reflectors and use these for all of the demonstrations and experiments.

6. The demonstration test plan for the Corps phase of the program was intended to simulate typical hopper dredge maneuvers. The three maneuvers selected to simulate were:

- a. Dredge cuts parallel to channel center line and with increments offset from center line.
- b. A turn at two defined points in a simulated three-segment channel.
- c. A U-turn.

The navigation system was to display to the dredge operator the distance from each turn and the offset from center line during these boat operations.

7. The demonstration test plan for the CG phase of the program was intended to evaluate the system for buoy setting maneuvers. The simulation selected for this part was (a) simulation of buoy tender maneuvers and (b) determination of resolution of the positioning system.

8. An important aspect of this phase of the development program was a demonstration of system operation to selected representatives from Corps offices in various parts of the country. This approach gained direct feedback for the program from men who are knowledgeable users of electronic distance measuring equipment and automatic data processing systems. It was felt that guidance from a group such as this would be of great value in evaluating the system potential and in guiding subsequent phases of the development. After several delays and postponements, demonstration maneuvers were run, during November 1976, in the area between Georges Island and the navigation light. The barge was programmed to follow a hypothetical channel which included three straight sections and two turns. Distance to turn and offset from center line were displayed as a simulation of dredge operation. Corps representatives who attended the demonstration and participated in the related discussions were as follows:

Mr. N. H. West, Portland District
Mr. A. L. Wilkerson, Memphis District
Mr. R. A. Pruhs, Norfolk District
Mr. H. R. Spies, Philadelphia District
Mr. F. Ciccone, NED
Mr. S. Fistel, NED
Mr. Neil Samuels, OCE
Mr. G. C. Downing, WES

9. Coast Guard representatives were given demonstrations of the PRANS operation during maneuvers simulating buoy tending. Comments from CG personnel indicate the demonstration was a valuable exposure for the attendees. A CG report on the PRANS project has been prepared by the R&D Center at Groton, Connecticut. This report is entitled "Tests, Demonstration, and Evaluation of ACCI Developed All Weather Precise Navigation Systems for Applicability to Navigation Aids Operation." The report describes the system demonstrated and gives an extensive analysis of the resolution test data. It concludes that PRANS is a

viable candidate for further development. CWO Bob Couchman was in charge of the CG phase of this program.

10. The resolution test of the PRANS was made by moving the test barge SALEM along the dock on Georges Island and tying up at 5- to 10-ft intervals along the dock pilings. The 5- to 10-ft movements were set with a mechanical tape measure. Cross comparisons of the PRANS data, the Autotape data, and the dock position data were made. The CG R&D Center made an extensive analysis of the resolution test data. During the data gathering phase of the program, a large number of replicate readings were taken so that statistical techniques could be applied with a high level of confidence. Analysis procedures and results are included in the referenced CG report. A summary of the data analysis results from the CG report is included as Table 1. These results illustrate the very high resolution capability of the PRANS equipment.

PRANS DESCRIPTION

Components

11. For the field demonstration of the PRANS technique ACCI assembled a shipboard system composed of electronic equipment components used in previously conducted St. Lawrence Seaway tests but modified for the Corps/CG evaluation program. These components were on loan from the St. Lawrence Seaway Corp. for the duration of this test program. Conventional radar components were used for the microwave sections of the system and a PPI display was available for its regular pilot guidance use. Major components of the system consisted of the items described in the following paragraphs.

a. Radar - A Decca marine radar unit was modified by ACCI to meet PRANS requirements. The antenna and associated pedestal were mounted on the deck of the barge SALEM for the demonstration. The radar display unit was mounted in the cabin of the SALEM. This item was on loan from the St. Lawrence Seaway Corp.

b. Gyrocompass - A Model 301 Sperry gyrocompass was leased for the period of the field trials. This unit provided azimuth information to the computer and enabled it to adjust the azimuth gates around the reflectors as the boat moved.

Table 1

Summary of Data Reduction Static Tests

Expected Value* (EV)	PRANS Sample Mean ($\bar{m}$)	PRANS Difference EV - $\bar{m}$	PRANS Standard Deviation	Auto-Tape Sample Mean ($\bar{m}$)	Auto-Tape Difference EV - $\bar{m}$	Auto-Tape Standard Deviation
Ranging Evaluation (All Units Are in Feet)						
10,435.5	10,435.5	(Initialization)	0.8	10,435.5	(Initialization)	14.0
10,432.0	10,432.0	0.0	0.8	10,431.4	0.6	13.1
10,428.5	10,428.9	-0.4	0.8	10,426.7	1.8	6.2
10,421.6	10,420.9	0.7	0.7	10,414.4	7.2	9.8
10,414.7	10,414.1	0.6	0.7	10,405.6	9.2	6.7
10,407.7	10,406.3	1.4	0.8	10,397.9	9.8	8.3
10,435.5 (1)	10,436.0	-0.5	0.8	10,445.5	-10.0	22.5
10,428.5 (1)	10,429.2	-0.7	0.7	10,426.4	2.1	13.0
Distance to Turn Evaluation (All Units Are in Feet)						
15,270.45	15,270.45	(Initialization)				
15,265.5	15,265.1	0.4				
15,260.5	15,260.0	0.5				
15,250.5	15,249.0	1.5				
15,240.5	15,239.2	1.3				
15,230.5	15,228.4	2.1				
15,270.5 (1)	15,271.1	-0.6				
15,260.5 (1)	15,260.6	-0.1				

* Expected values based on measured movement of the barge along the pier from the initialization position.

Note: (1) The observations of the first two positions were repeated approximately 3.5 hr later. All of the above data provided by the U. S. Coast Guard R&D Center, Groton, Connecticut.

c. Data Terminal - A Texas Instruments Model 733 data terminal was used for computer input and output functions. The keyboard allowed rapid program modification. Data collected during test periods were printed by the 733. This unit was supplied by ACCI.

d. Display Panel - A display built by ACCI for the St. Lawrence Seaway program was installed to demonstrate how information can be supplied to the pilot. This unit was modified for the dredge program to indicate distance from center line of programmed channel and also distance to end of a cut.

e. Computer and Associated Circuits - A minicomputer used in the St. Lawrence Seaway program was used in these tests. Some of the associated circuitry was modified to match the Corps program needs. The computer processes inputs from the radar receiver, the gyrocompass, and the data terminal. A stored program executes the needed computational and control functions.

f. Software - Systems software is a key element in the PRANS operation although it is not a visible item. A fast and efficient program instructs the computer when to open radar receiver gates, computes geodetic position from the two range measurements, and directs the processed results to the output devices.

g. Microwave Reflectors - Reflectors mounted on the shore constitute the foundation of the PRANS. Without these relatively simple components the rest of the system is inoperative. For these tests, ACCI fabricated corner cube-type reflectors from sheet aluminum. One of these reflectors is presented as Figure 1. The reflectors used have approximately one-metre-square sides.

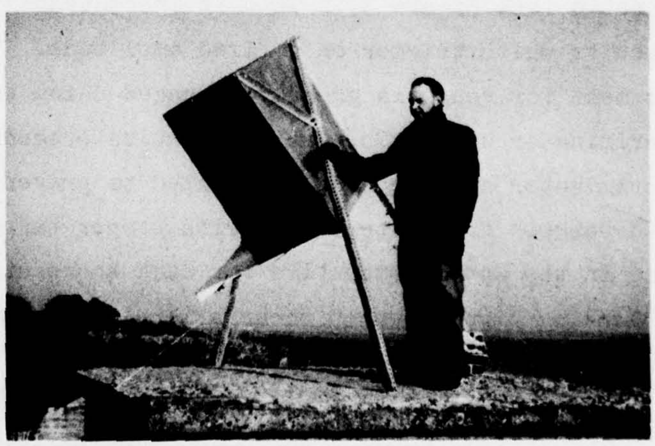


Figure 1. Typical microwave reflector

Circuit functions

12. To better illustrate the functions and interrelations of the various components, a simplified block diagram of the PRANS is given in Figure 2. In this diagram the control and data paths can be readily visualized and some of the special circuits associated with the computer are shown. A linear gain receiver section was designed and built by ACCI as an input to the computer controlled detection circuits. This is in contrast to the logarithmic gain receiver normally used in a radar receiver to enhance the weak echoes which are received from natural surfaces such as shoreline, trees, small boats, etc. With a linear receiver amplifier as used for the PRANS detector, radar returns from good microwave reflectors are generally large compared with natural shoreline echoes. The radar antenna transmits and receives energy in a narrow azimuth angle (approximately 2 deg) and is coupled with the remainder of the radar system through a transmitter/receiver (TR) switching unit. A sensor attached to the radar antenna, as an ACCI modification, detects the antenna azimuth with respect to the boat axis and the signal is transmitted to the PRANS computer for processing. The gyrocompass provides the computer with boat heading information. The constant fraction discriminator is the single most important component necessary to deliver the high resolution of the PRANS. This unit detects the same point on a reflected signal pulse even when the signal amplitude changes over a large ratio (see Figure 3). This is in contrast to most pulse detection circuits which trigger on a fixed amplitude. The time interval measurement for range is greatly enhanced using the constant fraction discriminator unit. The gating circuits preceding the constant fraction discriminator are computer controlled to prevent reflections from undesired targets from interfering with proper target detection. By programming in the approximate time for each shore station signal to arrive, and blanking signals which occur prior to this time, the time interval measurement for range is maintained valid even where strong and unwanted natural reflections exist ahead of and behind the target reflector. A diagram illustrating the range gate function is given in Figure 4. The computer also controls the signal gate on the basis of

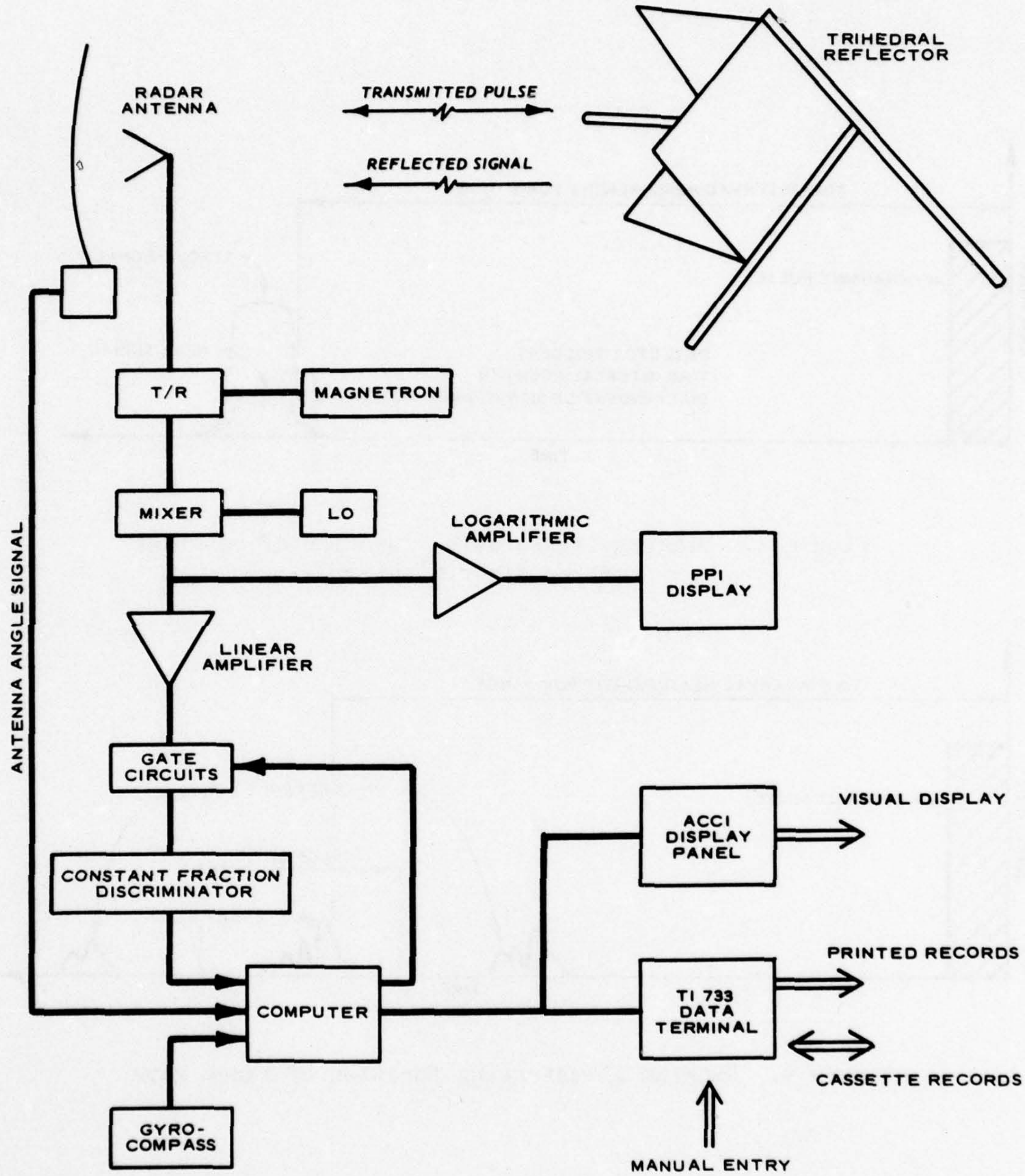


Figure 2. Block diagram of PRANS functional components

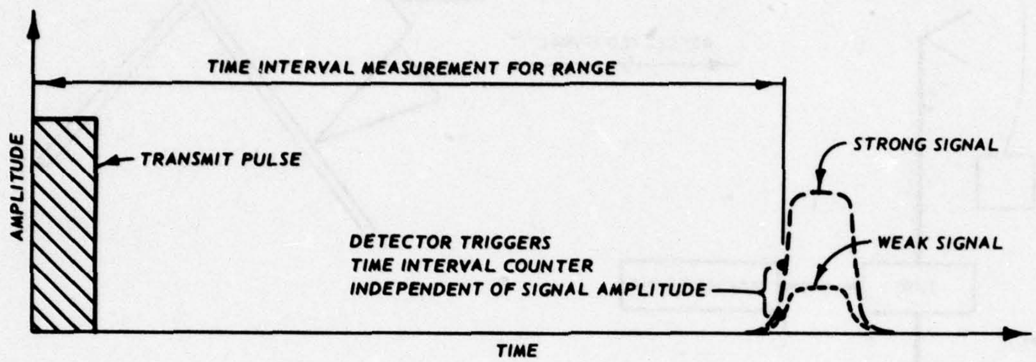


Figure 3. Diagram illustrating function of constant fraction discriminator

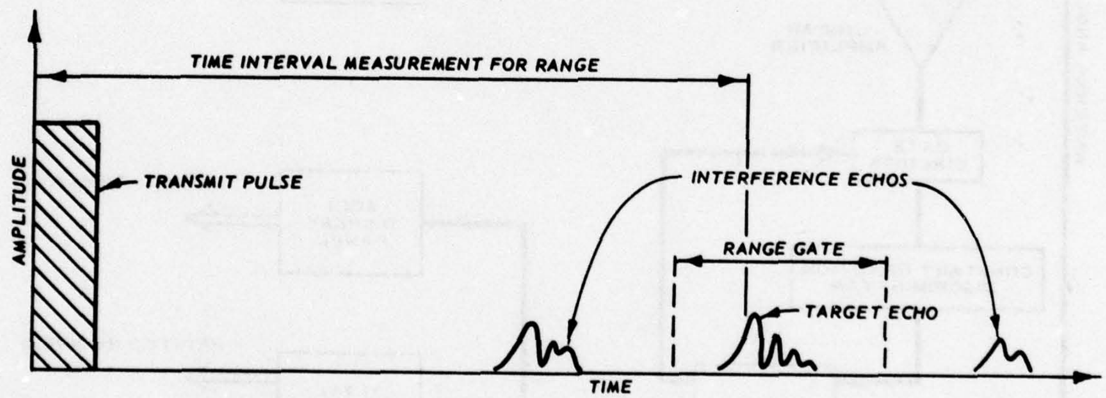


Figure 4. Diagram illustrating function of range gate

azimuth using the antenna azimuth signal and gyrocompass signal for references. By programming the approximate azimuth for each shore station and blanking signals which occur outside these limits, a strong discrimination is achieved against unwanted natural reflections from either of the target reflectors. Figure 5 illustrates the azimuth gating function. The combination of range and azimuth gating provides

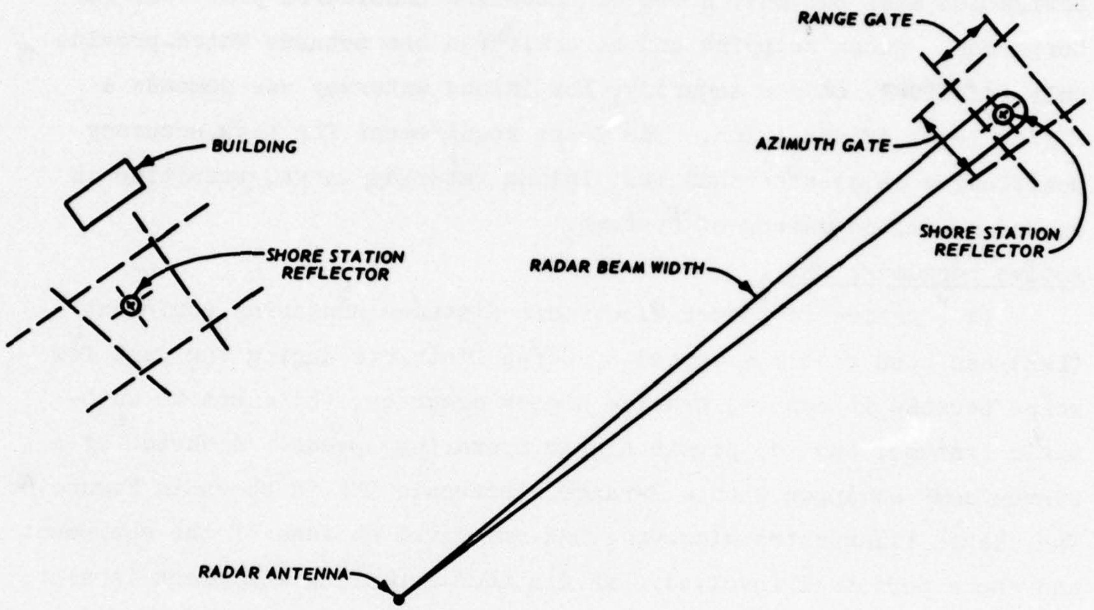


Figure 5. Diagram illustrating function of azimuth gate

a very effective shield against unwanted reflections. The computer program adjusts the range and azimuth gates for each antenna rotation to accommodate the movement of the boat. The computer program is also designed to shift to a new set of gates when the boat leaves the area covered by one set of reflectors and enters a new area.

COMPARISON OF POSITIONING TECHNIQUES WITH PRANS

General

13. In order to set the passive reflector positioning technique in proper perspective, it will be useful to review positioning techniques in general and how these relate to Corps use. This review will

assist projecting the course of development and the relative merits of competitive systems. For instance, with the manual methods used by the Corps in past years, the measurement medium was either optical (via transits) or mechanical (via tapes, cables, wires, etc.). Newer techniques in use by the Corps involve acoustic and microwave energy for determining positioning. There is a wide variety of possibilities for navigation aids but only a few of these are considered practical for Corps use. Ocean shipping and aircraft can use methods which provide only relatively coarse accuracy, but inland waterway use demands a higher level of precision. The Corps requirement for high accuracy positioning is greater than most inland waterway users, resulting in use of a limited number of systems.

Active responder DME

14. Active responder electronic distance measuring equipment (DME) has been widely accepted by Corps Districts during the past few years because it can (a) provide higher accuracy, (b) adapt to automatic systems, and (c) permit higher operating speeds. A sketch of a survey boat equipped with a 3-range electronic DME is shown in Figure 6. The sketch illustrates microwave DME and gives an idea of the equipment and shore personnel involved. RF distance-measuring equipment is also used by some districts because it provides nonline-of-sight use while all microwave equipment requires line-of-site. Various local conditions and operating modes determine the optimum choice between types for a given application. Acoustic active responder systems are impractical in inland waterways because of the shallow water, compared to offshore, and the irregular bottom contours.

Passive reflector DME

15. Figure 7 illustrates the equipment needed for a 3-range passive reflector system as a direct comparison with the microwave DME illustrated in Figure 6. The notable difference between the systems is the absence of shore personnel. Accuracy and compatibility with automatic systems are equivalent. Other comparisons of the two types of systems were discussed in the introductory section of this report.

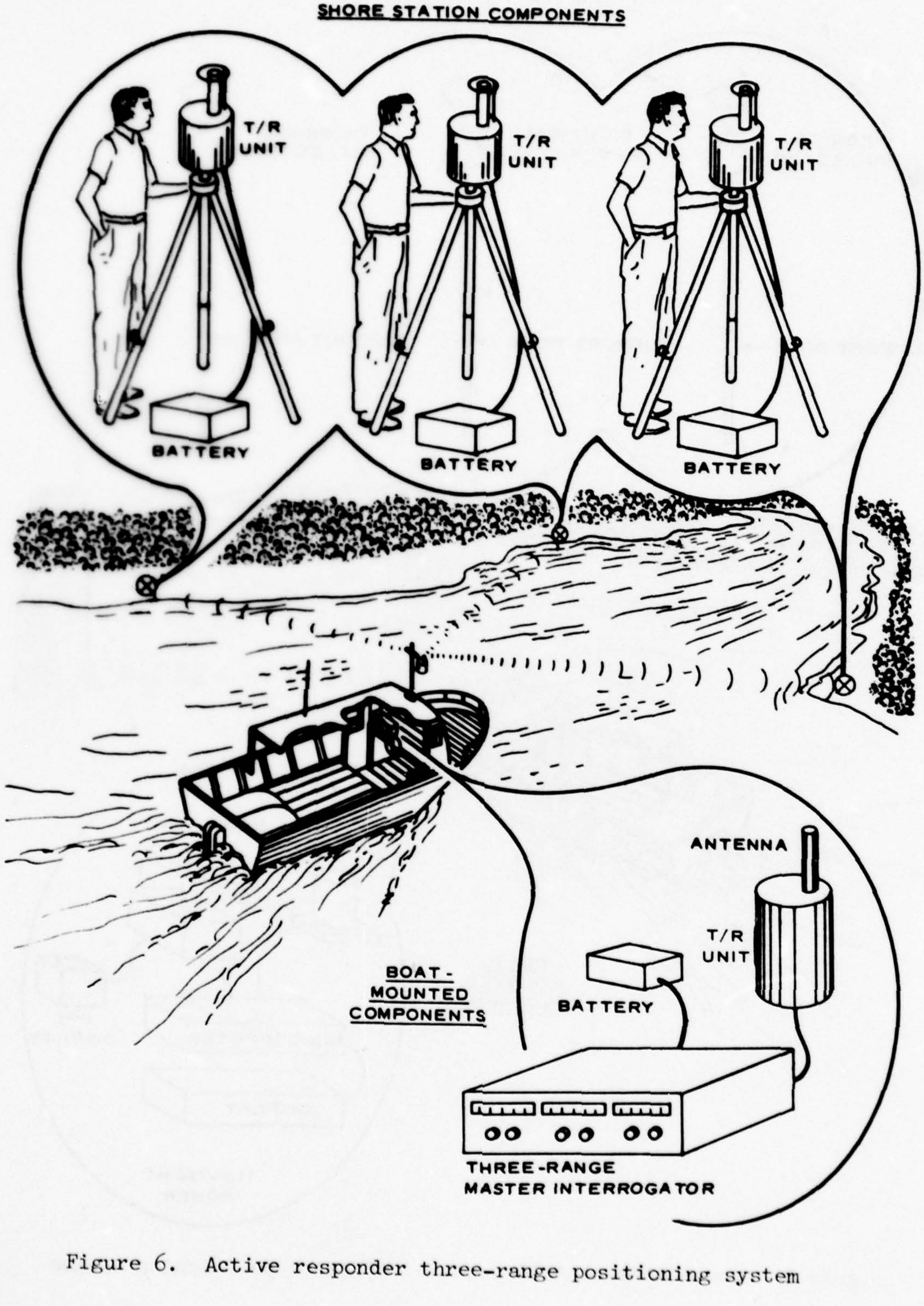


Figure 6. Active responder three-range positioning system

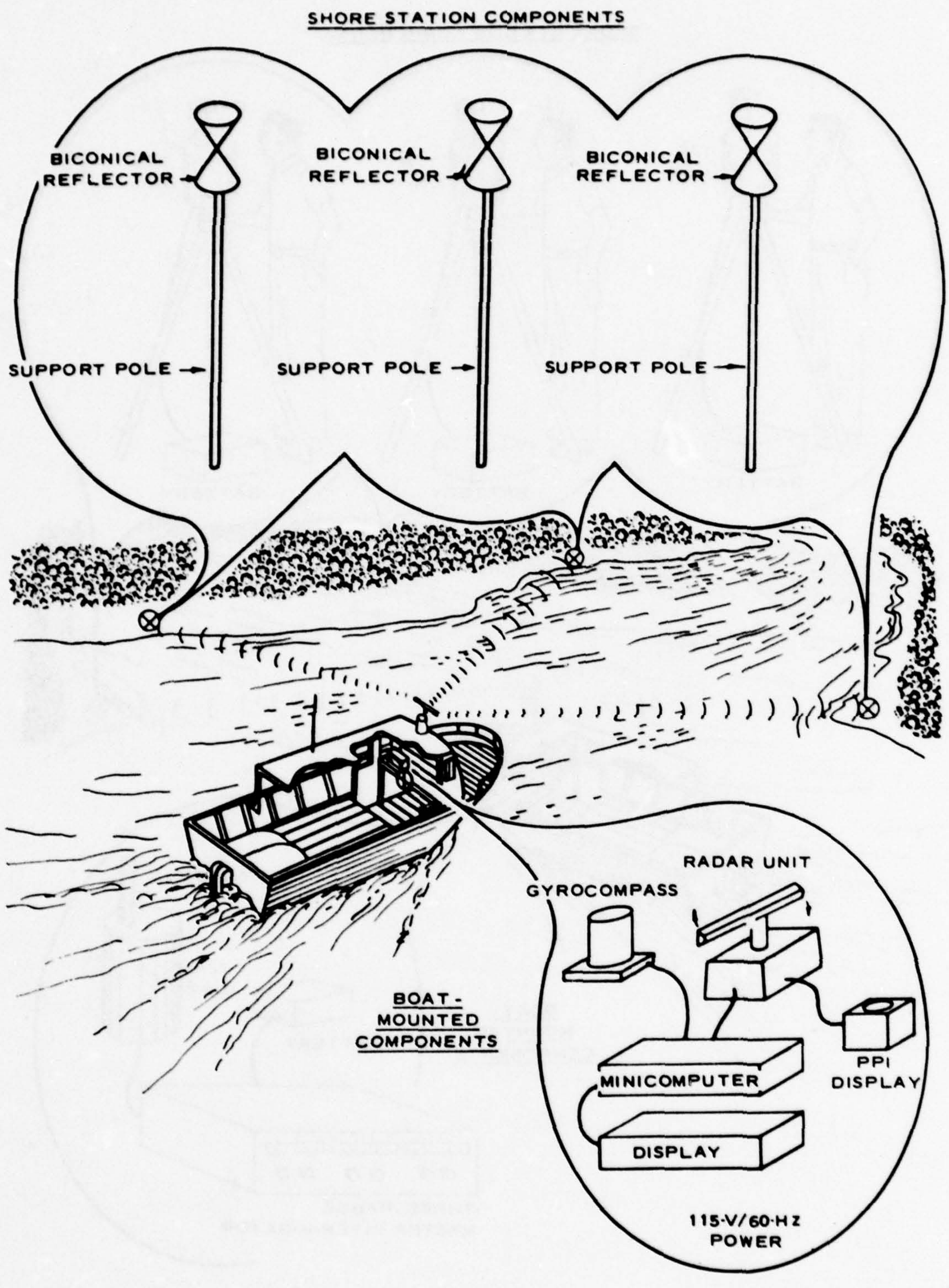


Figure 7. Components of ACCI passive reflector positioning system

Doppler navigators

16. Doppler navigators are used by several Corps Districts and Labs for specialized uses. All marine doppler navigators are based on acoustic reflection from the waterway bottom. The principle upon which this equipment is built is that a shift in frequency will occur between transmitted and reflected energy when a source is moving relative to a reflector. Doppler navigators can be built using optical, electrical, or acoustical energy but for boat use acoustic energy is the only practical underwater technique. For boat navigation, a complete system would include a 2-axis doppler system, gyrocompass, and a computer with display appropriate to the job. The computer can integrate the boat course from a starting point and plot the position of the boat wherever it is piloted and without any reference other than a firm waterway bottom. This latter point can be a very considerable advantage since shore stations are not required except for a starting point reference and periodic checkpoints. By greatly reducing the need for shore reference stations, a doppler navigator can, in some instances, give versatility not possible with electronic or optical DME. For instance, a boat can be navigated around bends in rivers and harbors where the setup time for electronic DME would be very costly. A doppler navigator system can also operate offshore beyond reasonable line-of-sight conditions. Another example would be the situation where a hopper dredge needs guidance from a shoal area to a dumping ground. A doppler navigator could provide this capability much easier than electromagnetic DME, provided other conditions are satisfied.

17. There are several significant and severe limitations to acoustic doppler navigators for Corps use. As a fundamental constraint, the integral of velocity is displacement but with an error which is cumulative with time. Thus, a boat navigating with this method will have an error which increases in magnitude with the length of time since the last reference position check. Another severe constraint for Corps use is the stability of the bottom, since this is used as reference reflection. In many rivers, there is a layer of sediment moving along the bottom of the channel. This moving layer is highly reflective

to acoustic energy and appears as a false bottom to the signal analyzing circuits. Since the doppler shift is derived from the relative motion of the boat and the bottom, as determined acoustically, it follows that the true velocity of the boat will be in error by the velocity of the moving bottom. This effect limits the use of doppler navigators to offshore areas or to inland waterways where there is very little sediment being transported. Another constraint worth mentioning is the depth range over which an acoustic doppler unit is effective. For offshore work, the water depth may become too great for the reflected signal to be detected and the signal processing equipment will shift to water track mode and give reduced accuracies. Some doppler equipment is designed for deepwater work but generally these use lower frequencies to get lower signal attenuation and have reduced accuracy as a result of this compromise. Doppler navigators are widely used for oceangoing vessels but due to the limitations mentioned above, they have found relatively slow acceptance by Corps personnel. Looking to the future, doppler navigators may find considerable use as supplements to electronic DME.

Satellite navigation

18. For ocean shipping use, doppler navigators are used in conjunction with a satellite positioning system. The satellite system gives a position update on approximately an hourly basis, thereby, resetting the doppler navigator integral drift to essentially zero at each update time. Between satellite fixes, the doppler navigators keep the ship so equipped on course. The two techniques thus complement each other very well in this application; the doppler providing continuous high-resolution, short-term positioning information and the satellite system correcting the long-term drift of the doppler system. This works very well for open ocean navigation but the satellite fixes are too far apart in time to be adequate for Corps work. In an hour's time lapse the cumulative error of the doppler system would be too great for survey work. The NAVSTAR satellite navigation system is planned for operational readiness in 1988. It will have a calculated accuracy of ± 10 m in the horizontal plane and ± 8 m in the vertical. This accuracy

capability will be excellent for aircraft and offshore navigation and will be adequate for some inland waterway uses. The NAVSTAR system will have 24 satellites orbiting in such a pattern that at least four will be within line-of-sight 24 hours per day. If its projected accuracy is achieved in practice, NAVSTAR will exceed the accuracy of LORAN and DIFFERENTIAL LORAN. The projected accuracy of ±10 m is, however, not adequate to meet the range accuracy for Corps hydrographic work which most Districts consider as requiring ±3 m or better in resolution and repeatability. Thus, even without considering the long time lag before NAVSTAR is operational, the development of passive reflector systems does not pose a duplication of effort.

Compound positioning systems

19. While the satellite/doppler combination is inadequate for inland waterway surveys, and electronic DME/doppler combination may be very useful in some instances. A doppler navigator operated in conjunction with a microwave DME would extend the area of coverage of a given set of shore stations. The doppler navigator could maintain course through blind spots, interference zones, and where the geometry of the DME is poor. Either active responder or passive reflector DME can be used in conjunction with a doppler unit.

Waterway/reflector considerations

20. If a waterway is permanently equipped with passive reflectors suitable for general marine use there are possibilities for savings which are not apparent if only the old ways of doing things are considered. Commercial shippers with PRANS-type equipment aboard could operate with greater efficiency and safety than with the present visual navigation aids. Greater efficiency would accrue from less weather dependence and also from better boat control. By reducing or eliminating dependence on visual aids, the boat operators could operate in weather which otherwise causes them to lay over. Boat operators could also reduce energy consumption by making more precise settings of rudder and power on the basis of more precise position location and speed information.

21. Another concept made possible when a waterway is equipped

with general purpose microwave reflectors is the use of a magnetic information storage map. A traditional map is made of paper with emblems and diagrams printed upon it and is designed for humans to read and interpret. With a computer aboard, information storage and retrieval is no longer limited to a human reader. A map consisting of a magnetic tape cassette could give a boat control computer the information needed to guide the boat from port to port. Figuratively speaking, the computer map could paint a center line down the waterway as was done years ago with roads. Computer controlled CRT displays could also give better limited area coverage for human monitoring of boat progress than is practical with conventional maps. Frequent revision would be a big advantage on waterways where the channel changes rapidly as it does on the Mississippi and tributaries. As an example, a boat captain could pick up a map from a port authority office for a trip upriver. The map would contain the latest (weekly) channel information with position being referenced to the reflector shore stations along the waterway.

22. If the preceding computer control and display of channel information is effected, it becomes possible to consider a change in navigation aid requirements. Channel marker buoys are costly and difficult for the government to maintain. If adequate channel definition can be supplied from a computer map, buoy tending could be reduced and perhaps even eliminated with a resulting savings of many dollars. Another indirect savings would be to place the government in a stronger position where lawsuits against the government are based on navigation aid mislocation. Buoys can move but shore stations will not, short of destruction. Basing channel location on shore station reflectors thus has potential for improving service to shipping and at the same time reducing government cost and liability.

23. Corps savings alone on a waterway permanently equipped with general purpose marine microwave reflectors would be considerable. Dredges and survey boats would no longer be required to set up, man, and maintain the active responder or transmit stations now needed. The cost reduction due to reduced field crews would be substantial but other indirect savings could also be anticipated. Corps boats could

have greater freedom of movement to survey efficiently rather than being constrained to an area covered by two or three shore responders. We can also consider the possibility of collecting channel surveillance survey data by boats running up and down a given waterway for other purposes and thereby supplying some types of hydrographic survey data without sending government crews out specifically for that purpose. A simplified sketch illustrating a waterway equipped with permanently installed reflectors is shown in Figure 8.

Other passive
reflector radar equipment

24. The passive reflector technique is not limited to the system evaluated in the subject test program. Several companies build precision digital ranging units which can be adapted to existing radar sets. Alpine Pioneer, Inc., manufactures a digital radar ranging unit which is manually balanced and because of its greater simplicity is much lower in cost than a computer controlled system. Because of the slow speed of a manually balanced unit, this system is envisioned as being useful for locating a boat at a fixed point. Setting buoys might be such a situation. Another example of an alternate passive reflector system is the portable range unit manufactured by NanoFast, Inc., in Chicago, Illinois. This is a single range automatic tracking unit with an accuracy of 6 in. in range. It may be an economical choice for small boats running single ranges.

Reflector design considerations

25. Reflectors for PRANS development are a key element in the success of the technique. The best imaginable shipboard equipment is useless without adequate shore reflector stations. Reflectors are basically simple and potentially low cost compared to active responder units but the multitude of factors which influence the design or selection of type is far from simple. As a PRANS component, the function of a reflector is to return a large portion of the radar pulse incident on it. A large signal return is desirable for proper signal detection, and to obtain a strong reflection it is necessary to have a large radar cross section. Thus, from an electrical performance standpoint, it is

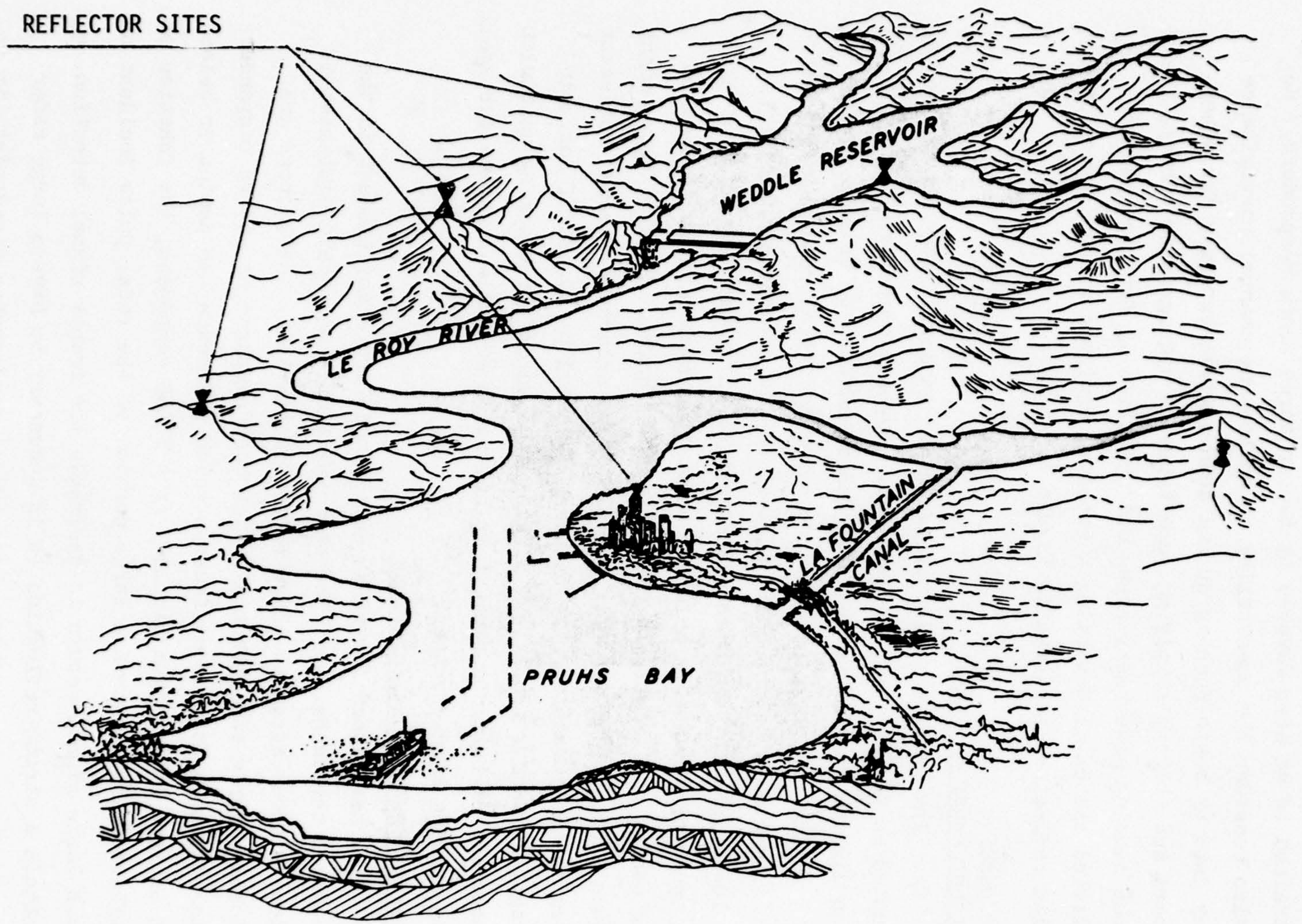


Figure 8. Inland waterway with permanently installed microwave reflectors

best to use a large reflector. Reflector installation and maintenance costs are however directly proportional to size. Performance and costs are thus in direct conflict. Optimum reflector design therefore requires a careful compromise between performance, as related to signal return, and the cost of a reflector installation at a given waterway site. For short ranges, less expensive reflectors can be used. Another factor which must be considered is the azimuth coverage required of a given reflector. Some types are omnidirectional and others are very narrow beam units. Beam width and signal return are inverse functions for a given reflector size so it is necessary to consider beam width as another compromise factor in design selection for a given site and use.

CONCLUSIONS AND RECOMMENDATIONS

26. The PRANS demonstrated the ability to provide guidance to dredge captains by displaying distance from center line and distance to end of cut while following a preprogrammed test course which included three straight sections and two turns. The test operations performed under the study contract described in this paper have substantiated the original conclusion that this positioning technique has considerable promise as a general navigation aid for inland marine and nearshore use. Both government and commercial marine operations can benefit from the availability of a navigation aid which can provide accuracy commensurate with the needs of restricted inland waterway channels. Usefulness of this technique will be greatly enhanced for Corps use and for other government agencies if microwave reflector navigation aids are installed and maintained by the CG as is presently done with optical navigation aids. For commercial shipping, it will be essential to have government supplied navigation aids to make the system practical. A key element in this program is therefore the cooperation and participation of a multiagency group interested in improving navigation techniques.

BATHYMETRIC SWATH SURVEY SYSTEM AND ITS POTENTIAL FOR EFFECTIVE BOTTOM MAPPING

by

CAPT Wayne L. Mobley
National Oceanographic and Atmospheric Administration

SUMMARY

National needs require improvement in present survey systems and techniques for acquiring and processing bathymetric data. Requirements for such data include their use in support of changing navigational usage of nautical and engineering endeavors. The objectives of the Bathymetric Swath Survey System (BS^3) Program are to improve the effectiveness of marine surveying, improve data quality, and provide useful engineering data for nautical charts and bathymetric maps. BS^3 operations can be divided into three areas:

1. West Coast and Alaska - shallow water operation.
2. East Coast, Gulf, and Great Lakes - shallow water operations.
3. Deep ocean operations.

The development of new instrumentation and operational techniques for the West Coast and Alaska shallow water operations is under way with the procurement of a modified General Instruments 21-beam BO'SUN sonar, which will be installed aboard the NOAA ship DAVIDSON. The surveying and processing techniques, aimed at improving the effectiveness of bottom mapping, will be demonstrated this spring in Puget Sound near Seattle, Washington.

NATIONAL NEEDS

Marine commerce is an essential element of our Nation's economic life and contributes significantly to the welfare and safety of people and property. The production of nautical charts and related data is required to satisfy navigational needs and to contribute to national goals such as managing ocean resources, developing basic science, and improving national defense.

While charts were originally devised to enable mariners to travel safely from place to place, they are now used for a multiplicity of purposes, such as the planning of marine ventures, the exploitation of ocean resources, management and use of the coastal zone, and implementation of pollution control measures.

The largest user of the products and services provided by the National Ocean Survey (NOS)/NOAA nautical charting program is the Federal Government, and over 50 percent of total chart production goes to satisfy defense requirements. Other Federal users include the U. S. Coast Guard, U. S. Army Corps of Engineers, and NOAA's National Marine Fisheries Services. In addition to their use in navigation, the charts facilitate leasing of mineral rights, planning of public works, environmental protection/restoration actions, and ocean science development.

In the private sector, the greatest use of nautical charts is in marine shipping, an integral part of the national economy from colonial days to the present. Nautical charts are vital in safeguarding passengers and the huge volume of marine cargo from the many dangers besetting waterborne transportation. Other significant users from the private sector include commercial fishermen, who use charts for navigation and to locate potential feeding grounds, and recreational boaters, who depend on nautical charts for safe and accurate navigation.

Because ship-supported launches are too slow and inefficient to cover the rather narrow but expansive areas of shallow water bordering the United States and its possessions, new, more efficient surveying technology is needed. Although it has been demonstrated that for surveying inshore areas field parties with launches are more efficient than ships with launches, increasing the number of field parties has not been shown to be more efficient than methods employing advanced technology.

OBJECTIVES

The objectives of the BS^3 Program are to improve the effectiveness of marine surveying, improve data quality, and provide useful engineering data for nautical charts and bathymetric maps.

The first step in meeting this objective was the procurement of a General Instrument BO'SUN multibeam sonar, modified, to develop, demonstrate, and evaluate techniques for hydrographic operation (Figures 1 and 1a).

This system was selected to meet the operational requirements aboard the NOAA ship DAVIDSON operating in the West Coast and Alaska areas.

OPERATING AREAS

NOS bathymetric surveying areas, categorized by water depth (Figure 2), are:

(1) Shallow Water (less than 3 fathoms). Water depths of less than 3 fathoms along the West Coast and Alaska are not normally surveyed except in flat bottoms. Areas where shallow depth surveying is required are primarily along the East Coast, in the Gulf of Mexico, and in the Great Lakes. In the past these areas have been surveyed with conventional methods, but such methods cannot provide the necessary bottom coverage and are considered inadequate for contemporary data requirements. The proposed BS^3 is also considered inappropriate for these waters. However, a program in photobathymetry and a cooperative Laser Hydrography Development Project with NASA are addressing the technique of surveying in these shallow water areas.

(2) Shallow Water (3 to 20 fathoms) - East Coast, Gulf, and Great Lakes. These areas are probably the most extensive, as well as the most critical to private, commercial, and military navigation. Present hydrographic operations are ineffective in locating obstructions. Wire-drag operations, however, will satisfactorily locate the numerous types of man-made obstructions normally found on the bottom. The general specifications for a BS^3 which would improve hydrographic surveying, as well as increase the chances of detecting underway obstructions, are:

(a) The system should be a combination of multibeam and side scan sonar suitably packaged for installation on a small craft which can operate up to 20 knots. This type of system would be in the 100- to 200-kHz range, with an analog ship chart similar to a typical side scan sonar record. All digital raw data would be recorded on magnetic tape for subsequent processing ashore or aboard a support ship. The sonar system could also be used as a sensor supportive of the BS^3 on a larger ship.

(b) An operational techniques development effort for such a system would be required. A system presently exists which, with modifications, could be developed to satisfy these operational requirements. In the shallow waters of the East and Gulf Coasts such a system would supplement wire-drag operations, and could provide much more cost-effective surveys for bathymetric mapping, nautical charting, and locating obstructions.

(3) Deep Ocean (20 fathoms). Operational requirements are somewhat different for deep water than for shallow water areas. Safety to surface navigation is not the critical issue. Control of the survey vessel is important if the bathymetric data are to be of use in mapping. An integrated navigation system is a must when surveying beyond the range of medium range positioning systems. Swath coverage must be as wide as possible without the outer beam data being degraded. The graphics may display the entire swath since we are not surveying primarily for hazards to navigation. Areas of special investigation may require 100 percent survey coverage. A swath position plot of these areas will be required.

(4) Shallow Water (10-300 fathoms) - West Coast, Alaska, and Hawaii. The nearshore waters along the West Coast are not very shallow; however, the underwater features are of such a rugged character that a multibeam swath sonar can be very effective in ensuring adequate charting of navigable areas. This requirement has taken on a very high priority with the advent of the very large crude carriers (VLCC's) and their use along the Alaskan and West Coasts.

The operational requirements for the prototype BS^3 designed to operate in these waters (Figure 3) are:

(1) The system must provide the hydrographer with information on position and least depth of shoals located between survey lines. From the data obtained from multibeam scans to either side of the vessel, the system will provide graphics which display the corrected vertical depth under the ship, as well as the corrected contour of features shallower than the under-vessel depths. All raw data will be stored for additional after-the-fact processing and will be distilled for Marine Center processing.

(2) The system is intended to eliminate the need for wire drag in West Coast operation. It will provide 100 percent coverage of the bottom and the information required to certify clear channels. However, over the terrains in which it will be required to survey, some of its outer beam data will be useful only for the qualitative real-time graphics display, whereas the more nearly vertical beam data will be used quantitatively for production of hydrographic and bathymetric smooth sheets.

SYSTEM CONFIGURATION

The system components (Figure 4) and configurations which are being developed by General Instrument Corporation (GIC) for NOS include the sonar subsystem and the data acquisition subsystem.

The navigation subsystem is presently on board the vessels.

The Heave Roll Pitch Corrector Subsystem (HRPCS) is being developed by the NOS Engineering Development Lab (EDL) based on the design of the Arthur D. Little Engineering Model. The primary effort is the implementation of the real-time digital processing which was previously implemented in analog form. An alternate system--the DATAWELL HIPPY 120, a new design of Datawell's Wave Rider heave-and-roll pitch sensors and digital processor in one package--will be evaluated.

The Hydrographic Tide Telemetry and Logging Subsystem (HYTTLS) is also being developed by EDL. Based on previous successful tide telemetry projects, a design was formulated that will provide: Data for real-time zoned tide corrections during survey operations; hourly heights stored for up to 30 days during periods in which the vessel is nonoperational; or beyond telemetry range of the tide gages.

Additional miscellaneous subsystems to be interfaced with the system include a Sperry gyrocompass repeater which will provide digital heading. GIC will also provide a logarithmic left/right steering meter which will be installed on the bridge for the helmsmen. There will be various relay outputs for marking the various analog recorders (i.e., Raydist sawtooth, HYTTLS recorder) and a circuit to synchronize BS^3 with the NOS Hydroplot System.

The system hardware configuration is shown in Figure 5. The CAMAC* interface provides the mechanism for the simple and inexpensive integration of the various subsystems.

OPERATIONAL TECHNIQUES DEVELOPMENT

The modified BO'SUN BS^3 designed for West Coast shallow water

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* Triple IEEE Standards 583, 595, and 596 for connecting instrumentation and control devices to a computer.

areas must meet the following objective:

> Develop, test, and evaluate techniques using a modified BO'SUN multibeam sonar system for hydrographic operations so as to provide <u>useful</u> and <u>accurate</u> data for processing and verification of hydrographic and bathymetric survey.

The following system features would be <u>useful</u> to the hydrographer:

(1) The system will display all shoal features found in the deeper navigable water (10-300 fathoms) of the West Coast which lie in the swath of the system (2.6 times the depth), and which will provide 100 percent coverage of bottom and verification of all underwater natural features (Figure 6).

(2) The system will provide least depths over shoal features, real-time vessel position, and swath coverage so as to minimize development time (Figure 7).

(3) The system will permit the hydrographer to maintain quality control so as to provide the required information for nautical charting and bathymetric mapping (Figure 8).

System features <u>useful</u> for processing and verification include:

(1) Digital data which can be read and processed with minimum programming required at the Marine Centers.

(2) Processed data of higher quality than heretofore.

(3) A quantity of data required for verification which is equal to or less than that presently produced.

(4) Contour information which can be accepted, changed, added to, or rejected with minimum manual effort.

<u>Accurate</u> data in the ocean environment can best be defined in terms of precision and repeatability. The BS^3 must provide vertical data of equal or better quality than present systems and the horizontal location of contours must be more precise than the methods used heretofore.

<u>Surveying procedures</u> presently require navigation normal to or at angles up to 45° with the contour to permit the delineation of the features of the bottom (Figure 9). Line spacing is regulated by the depth of the water and scale of survey. The operation of the swath system heretofore has likewise been conducted normal to the contour in an attempt to make use of all depths which are stored and contoured after the fact. This procedure has had problems in junctioning. The procedures preliminarily envisioned for this type of system might include:

(1) Surveying parallel to the contour.

(2) Running crosslines at 90° with respect to the contour during low water and calm seas. The vertical depth will provide ground truth for contouring, or for verification of contours obtained from lines run parallel to the contours.

(3) Beginning hydrography midchannel in deep water and progressing shoreward.

(4) Regulating line spacing in accordance with coverage desired and as a function of depth.

(5) Regulating line spacing by navigation of ship along depth curves desired for charting.

(6) Determining least depth of features by surveying along ridge of feature.

(7) Determining the maximum depth of canyons by navigating along the canyon.

FIELD EXPERIMENT

The field experiment for the West Coast shallow water system is designed to provide a comparison with the present system (Hydroplot) and to demonstrate the aforementioned survey procedures (Figure 10).

(1) Three and a half months of dedicated ship time is planned with NOAA ship DAVIDSON.

(2) An area in Puget Sound near Seattle, Washington, representative of West Coast features, was selected with navigable depth ranges of 8 to 150 fathoms. The area provides excellent geodetic control for calibration and radio positioning as well as tidal benchmarks.

(3) A test survey at 1:5000 scale will be established so that a precise vertical profile over a variety of bottom features and depths can be established. The BS^3 will then be operated so as to provide quantitative data for analysis and characterization of the outer beams.

(4) An area will be surveyed twice at a scale of 1:10,000--once by the conventional survey method using Hydroplot and BS^3 operating simultaneously, and once with the BS^3 surveying parallel to the contour so as to provide 100 percent bottom coverage. Navigational control will be by conventional survey methods, such as Del-Norte, Raydist, etc.

(5) Additionally, areas which are of concern to deep draft shipping (VLCC) will be evaluated by reconnaissance surveys for comparison with previous wire-drag surveys.

CONFERENCE DEMONSTRATIONS

Conference Attendees will be able to observe a live demonstration of the SWATH System aboard the NOAA survey boat LAIDLEY this afternoon and tomorrow. A sample chart from the on-line plotter is shown in Figure 11.

GENERAL INSTRUMENT CONTRACT

OBJECTIVE: PROVIDE SYSTEM TO DEVELOP, DEMONSTRATE AND EVALUATE TECHNIQUE USING BO'SUN MULTIBEAM SONAR FOR HYDROGRAPHIC OPERATIONS SO AS TO PROVIDE USEFUL AND ACCURATE DATA FOR PROCESSING AND VERIFICATION OF HYDROGRAPHIC AND BATHYMETRIC SURVEYS

MILESTONE: JANUARY 78 INSTALLATION DAVIDSON

Figure 1

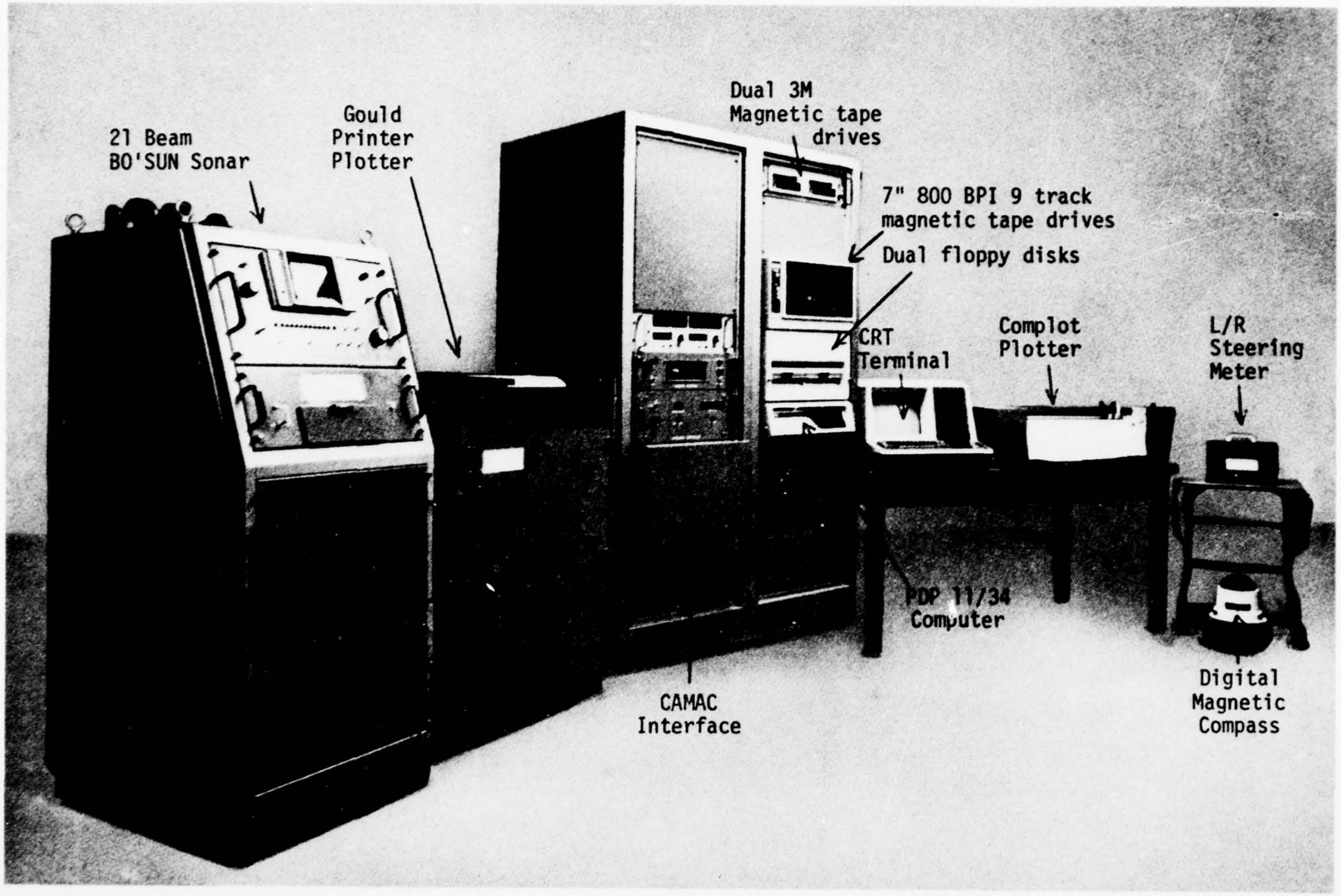


Figure 1a. Bathymetric Swath Survey System (BS^3)

OPERATING AREAS

Continental U. S. & Possessions

Shallow Water (less than 3 fm)

- BS^3 Inappropriate
- Photobathymetry
- Laser Scanning

East Coast, Gulf, & Great Lakes

Shallow Water (3 to 20 fm)

- Multibeam
- Side scan

Oceans

Deep Water (greater than 20 fm)

- Multibeam modified NBES
- Integrated Navigation

West Coast, Alaska, & Hawaii

Shallow Water (10 to 300 fm)

- Prototype BS^3
  Modified BO'SUN

Figure 2

REQUIREMENTS FOR:

HYDROGRAPHER

LOCATE SHOALING.

LEAST DEPTH ON SHOALS.

REDUCE TIME REQUIRED TO DELINEATE SHOALS AND CHANNELS.

INCREASE PROBABILITY OF DETECTING HAZARDS TO NAVIGATION.

REAL-TIME HARD COPY GRAPHIC DISPLAY.

PROCESSING

COMPUTER COMPATIBLE DIGITAL DATA.

MANAGEABLE VOLUME OF DATA.

VERIFICATION

IMPROVE ACCURACY OF ALL DATA.

LESS DATA TO ANALYZE.

GRAPHIC RECORDS FOR QUALITY CONTROL.

Figure 3

BS^3 HARDWARE COMPONENTS

SONAR SUBSYSTEM

G.I. 21 beam BO'SUN sonar (modified)

DATA ACQUISITION SUBSYSTEM

DEC PDP 11/34 64K, RT11 operating system
Dual floppy disk 512K bytes
Dual Magnetic tape drives (TS03)
CRT Terminal VT52AA

Gould 5005 Electrostatic Printer/Plotter

H.I. COMPLOT Plotter DP3

Qantex Dual 3M Magnetic tape drives

KSC CAMAC Interface

NAVIGATION SUBSYSTEM

Raydist, Del-Norte, or MiniRanger

HEAVE, ROLL, PITCH CORRECTOR SUBSYSTEM

A.D.L. Engineering Model modified by EDL, NOS, or
DATAWELL HIPPY 120 (alternative)

HYDROGRAPHIC TIDE TELEMETRY AND LOGGING SUBSYSTEM

EDL, NOS - Shipboard transmit/receiving station/logger with 4 tide gage site transmit/receiving stations

MISCELLANEOUS SUBSYSTEMS

Sperry Gyrocompass Repeater-Digital
G.I. Left/Right steering meter
G.I. Relay output, 8 channel for marking, bell, etc.
Hydroplot synchronization input

Figure 4

BS^3 HARDWARE CONFIGURATION

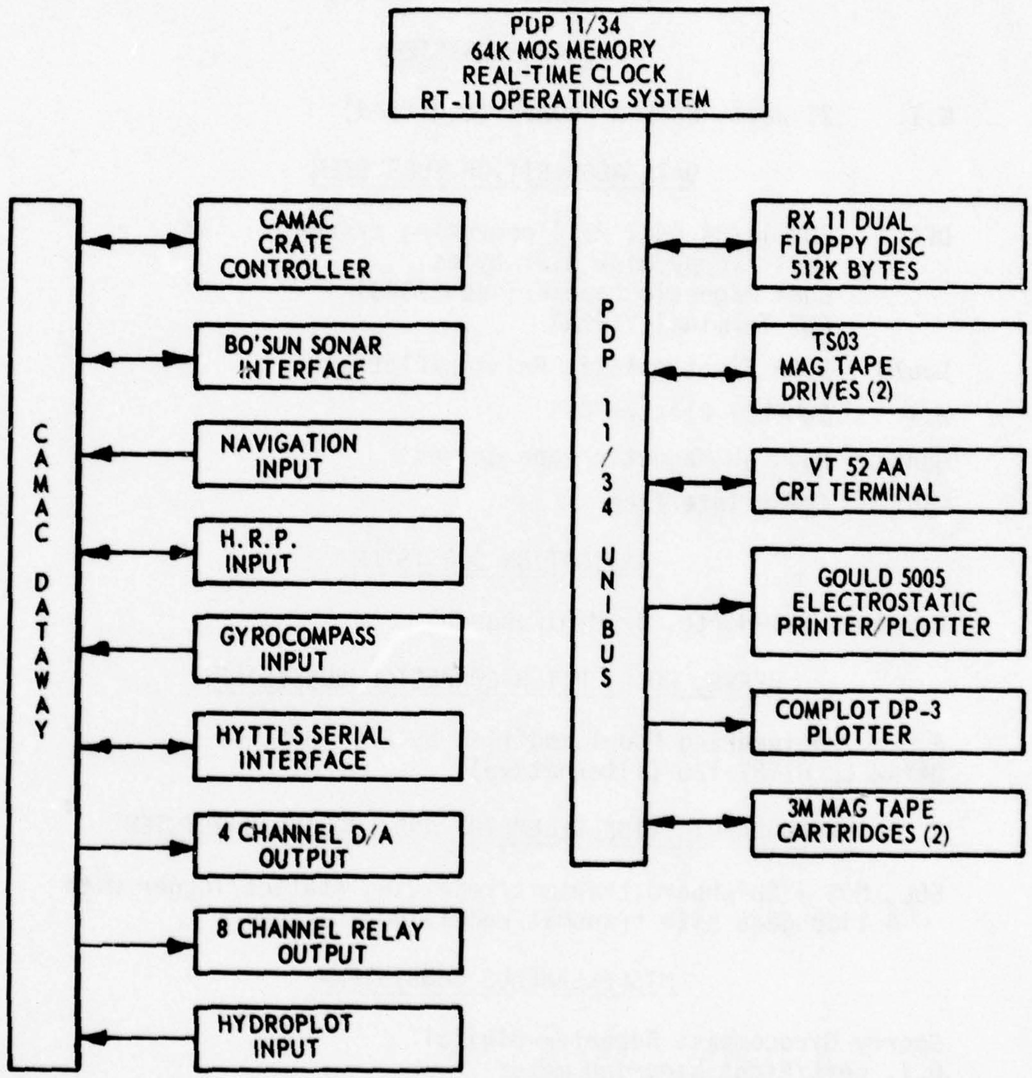


Figure 5

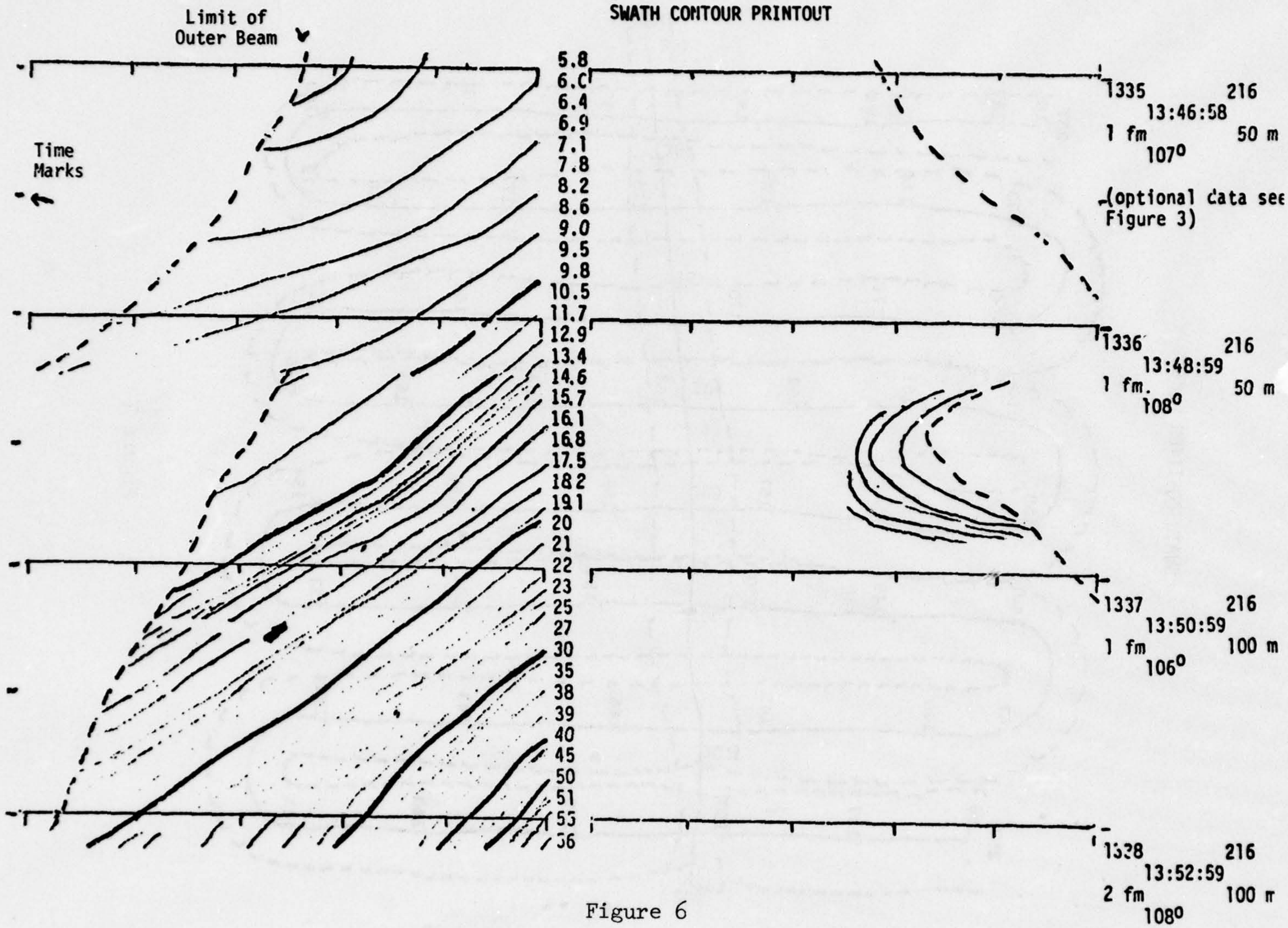

SWATH CONTOUR PRINTOUT
Limit of Outer Beam
Time Marks
5.8
6.0
6.4
6.9
7.1
7.8
8.2
8.6
9.0
9.5
9.8
10.5
11.7
12.9
13.4
14.6
15.7
16.1
16.8
17.5
18.2
19.1
20
21
22
23
25
27
30
35
38
39
40
45
50
51
53
56
1335 216
13:46:58
1 fm 50 m
107°
(optional data see Figure 3)
1336 216
13:48:59
1 fm. 50 m
108°
1337 216
13:50:59
1 fm 100 m
106°
1338 216
13:52:59
2 fm 100 m
108°

Figure 6

SWATH POSITION PLOT

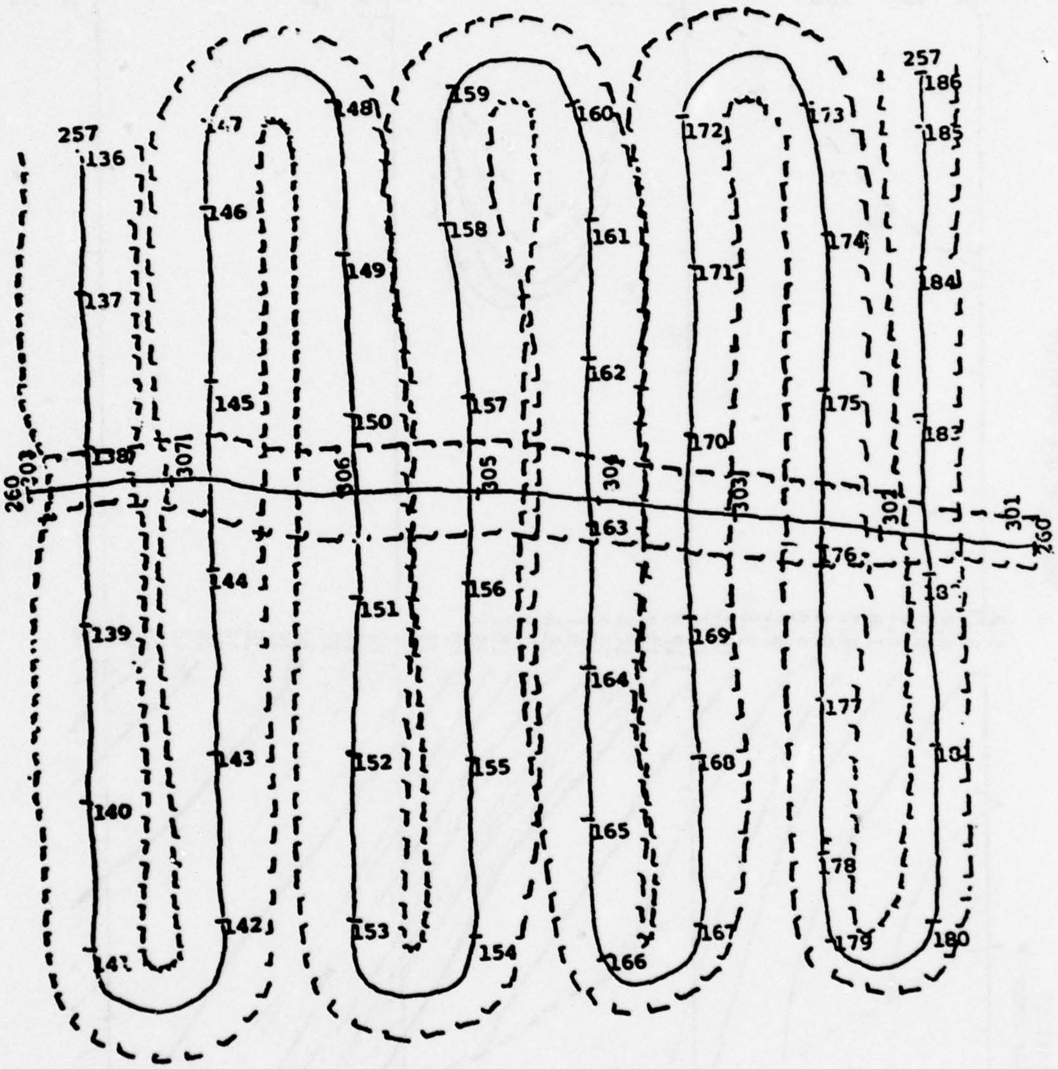
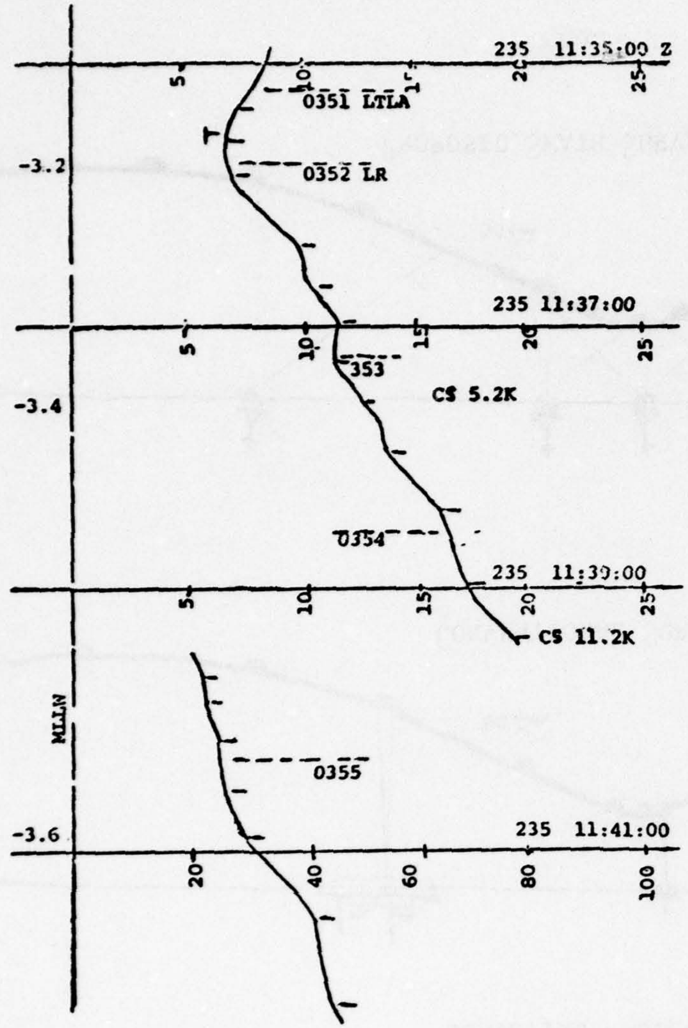


Figure 7

VERTICAL PROFILE AND SELECTED DEPTH PRINTOUT



	113517	0007.2	0399.51	0132.44	270°	
*	113528	0005.9	0390.42	0132.86	186°	AZ 273° di 01
	113558	0007.0	0389.38	0132.88	089	
	113621	0009.9	0399.37	0132.41	087	
	113639	0010.0	0389.37	0132.10	089	
	113658	0011.1	0389.36	0131.65	091	
	113712	0010.9	0389.36	0131.10	092	
	113731	0012.0	0389.36	0130.81	090	
	113757	0012.9	0389.35	0130.51	089	
	113829	0015.1	0389.35	0130.21	091	
	113859	0017.1	0389.46	0130.01	089	
	113922	0019.2	0389.35	0129.89	090	
	113940	0021.3	0389.35	0129.60	091	
	113954	0021.4	0389.34	0129.30	081	
	114012	0023.0	0389.34	0129.10	091	
	114032	0024.8	0389.35	0129.00	090	
	114055	0028.2	0389.32	0129.87	089	
	114131	0038.1	0389.32	0128.20	088	
	114233	0040.9	0389.32	0128.01	089	

Figure 8

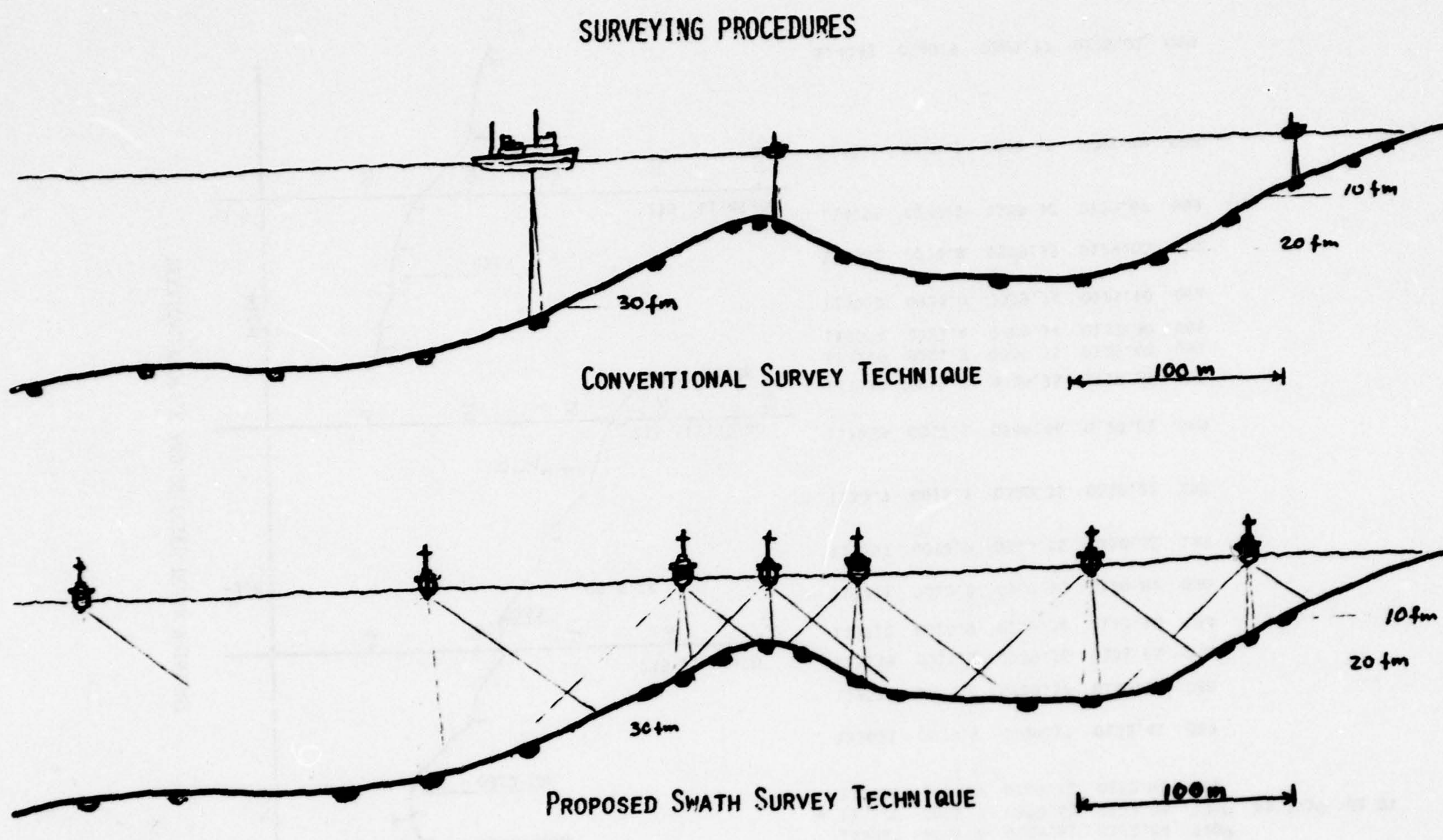

SURVEYING PROCEDURES
10 fm
20 fm
30 fm
CONVENTIONAL SURVEY TECHNIQUE
100 m
10 fm
20 fm
30 fm
PROPOSED SWATH SURVEY TECHNIQUE
100 m

Figure 9

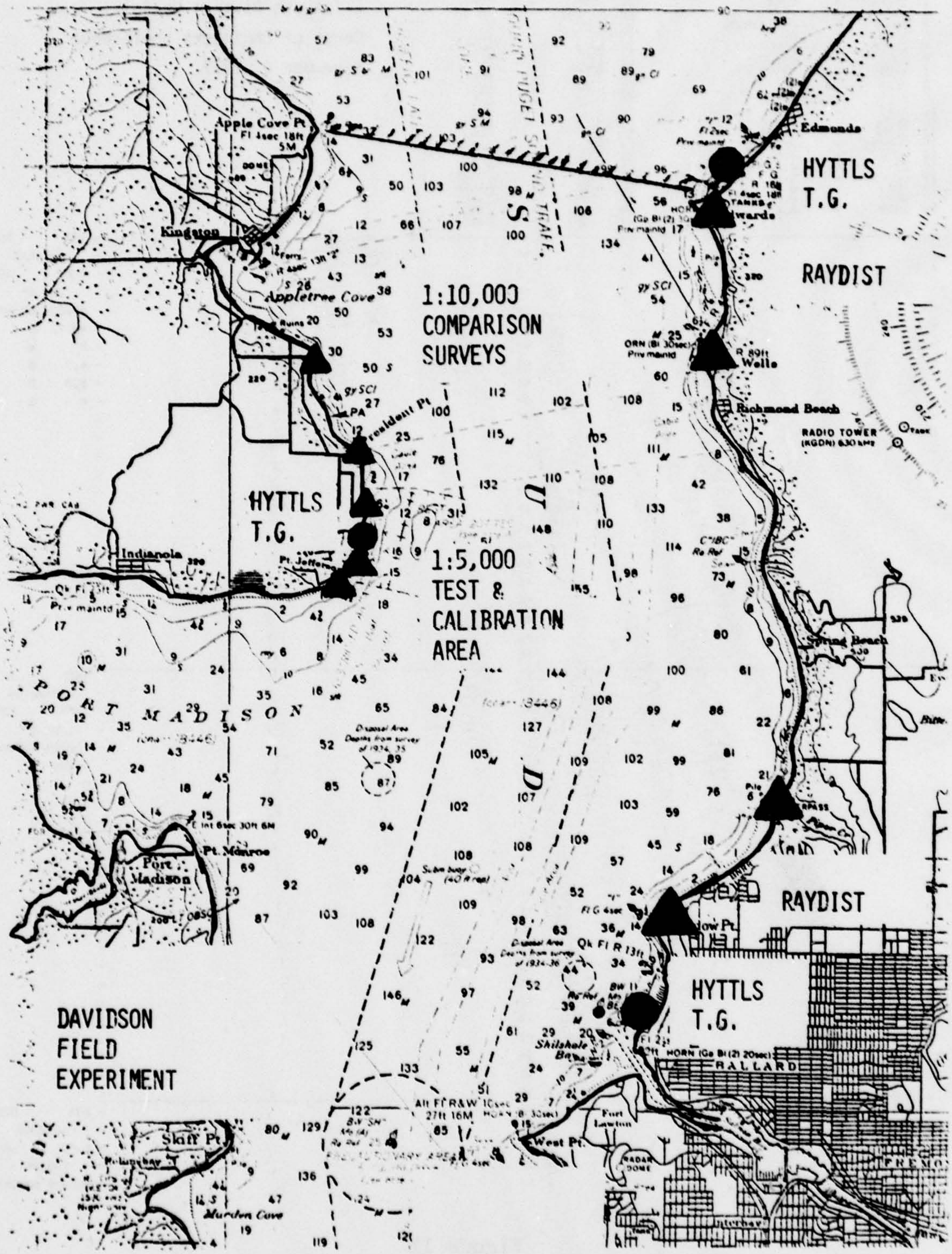

HYTTLS T.G.
RAYDIST
1:10,000 COMPARISON SURVEYS
HYTTLS T.G.
1:5,000 TEST & CALIBRATION AREA
RAYDIST
HYTTLS T.G.
DAVIDSON FIELD EXPERIMENT
Apple Cove Pt.
Kingston
Appletree Cove
Edmonds
Richmond Beach
RADIO TOWER
Indianola
PORT MADISON
Pt. Monroe
Port Madison
Skiff Pt.
Murden Cove
West Pt.
Fort Lawton
Shilshole Bay
BALLARD
Interbay

Figure 10

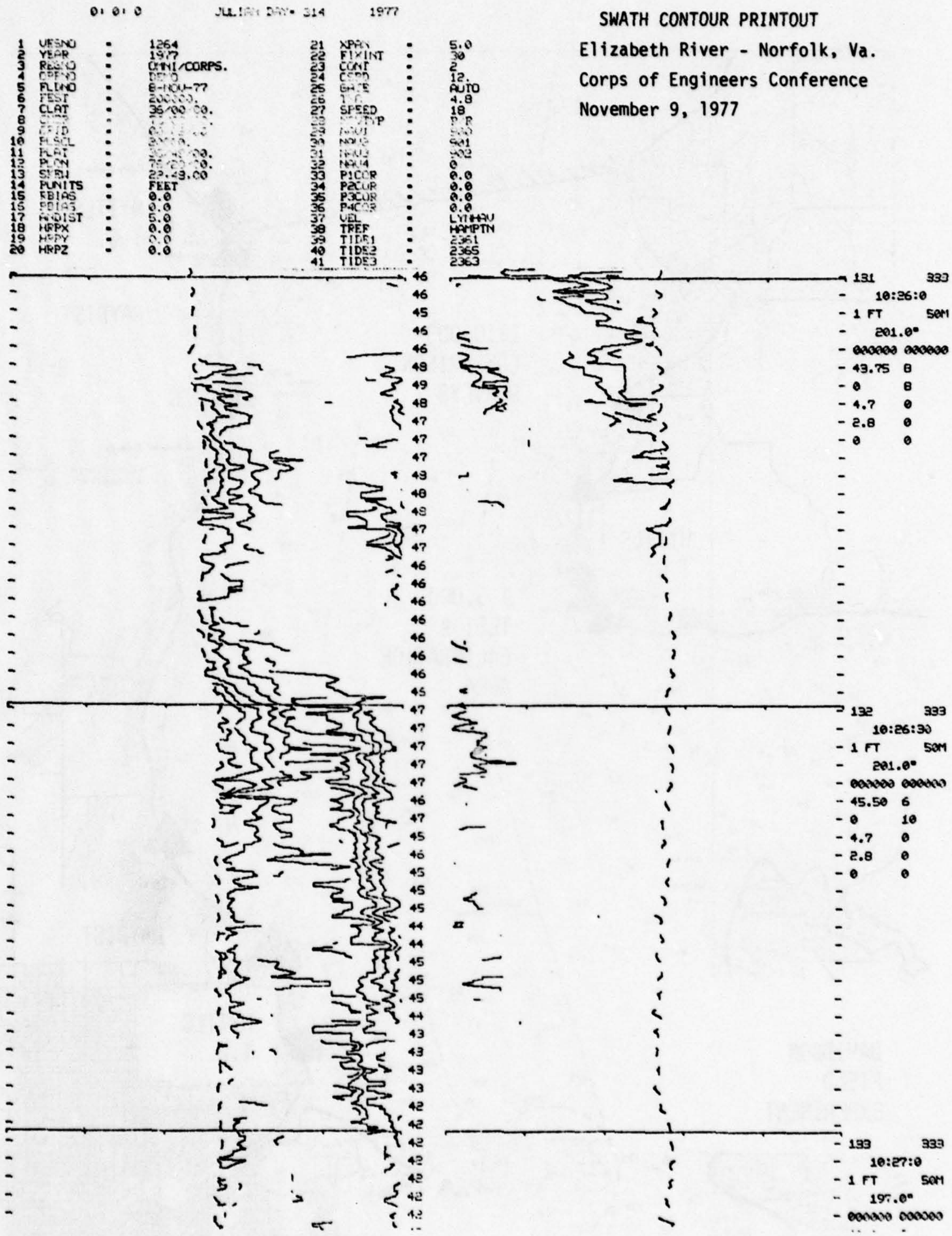

SWATH CONTOUR PRINTOUT
Elizabeth River - Norfolk, Va.
Corps of Engineers Conference
November 9, 1977
JULIAN DAY= 314
1977
10:26:0
10:26:30
10:27:0
1 FT
50M
201.0°
197.0°

Figure 11

AUTOMATED SURVEY SYSTEM - DATA PROCESSING

by

Orval J. McCoy
U. S. Army Engineer District, Wilmington

The Wilmington District is on the mid-Atlantic Coast with some 1500 miles of navigable channels, including two deepwater ocean ports. Our natural topography covers almost all features from deep ocean, shallow sounds, wide rivers and bays to narrow, winding, navigable rivers, power dams, reservoirs, and attendant recreational areas.

Since 1971 our District has had a Motorola Automated Survey System. This system is mounted in a 65-ft aluminum hulled boat drawing 5.5 ft of water at the skegs. System power is from a 20-kw generator.

Our initial goal, after the complete system became operational, was to utilize the survey system in as many areas as possible, reducing both field and office effort. With the many diversified hydrographic areas (deep and shallow water), two or more different sizes of boats would be required, all using basically the same type of equipment and following the same procedures. During the last 5 years almost all the areas that we could adapt the system to, and float the 65-ft boat in, were surveyed and processed. We are now ready for a smaller draft vessel equipped with the newer, smaller survey equipment.

The Wilmington District's initial concept of automated survey systems was not to just acquire survey data by automated means, but to have a completely integrated data acquisition and processing system that would produce a product in a final usable form to the various concerned departments, each department having access to and use of the data base generated by the survey system.

Our approach therefore was in two directions, but each dependent on the other so I cannot really separate the two operations easily. So, in general, I will present the field system first and the in-house system second.

The first step was to learn about our equipment, train the survey crew in its operation, and develop methods of field surveys. To adapt the new equipment to the old survey methods soon proved to be awkward and in some cases useless. So, taking a page from land surveying, we decided to "survey an area." In other words, develop a topo map of an area, then place the channel we were interested in, in that area. Limits of area were set to reduce over-survey effort, but current events have continually expanded the area of survey since the little extra time required in data acquisition is more than offset by the usefulness of the data by other departments.

Most of our channels are permanently established but the area principle still holds, with the exception that we know where the channel limits are and can run several times over each toe to ensure adequate coverage.

Learning about our equipment was harder than we thought. Manufacturer's performance statistics differed considerably with the dynamic situation of field surveys. All of us became extremely good detectives, knowing the performance statistics, then examining the equipment and analyzing the output data to determine the actual performance. Serious discrepancies were found and corrected, such as signal cancellation in the ranging system, time problems between the range acquisition and depth acquisition, depth editing, calibration difficulties due to warmup periods including the difficulties in setting up of sufficient calibration sites, and tape recorder problems that hopefully will be reduced with reel-to-reel tapes and standard tape formatting which, incidently, we have on our new Motorola Survey System just installed during the middle of September.

It was during this investigative stage that a single system (field and office processing) concept really paid off. Close cooperative effort by field and office did produce results. The slides will show some of the steps taken in-house to analyze and display field system performance so that proper evaluation could be made. (Slides are not included in this report.) Watching lights flash or examining masses of printed numbers is not the way to find out what is going on in the equipment.

Again, I emphasize that pictorial representation is the best way to really analyze the output of the various components of the survey system. A diagnostic series of computer programs that can periodically examine and plot the incoming data from the range console, fathometer, and plotter to verify field operation is essential. We are in the process now of displaying the various diagnostic programs on our Tektronix Graphic Terminal, thus shortening the verification process and eliminating a lot of paper.

As I mentioned previously, we have just purchased a new Motorola Survey System and installed it temporarily on our 65-ft vessel for system verification, checkout, training, and to provide time for in-house computer program modifications. This new system uses the MiniRanger III operating in the "C" Band 54-56 MHz, an M6800 Micro Processor, reel-to-reel and cassette tape, optional recording functions, and a 20-in. Houston Instruments Plotter.

The system is currently being tested and it works beautifully. All operator inputs are responses to computer-generated questions, thus extremely easy to learn to operate. The system is small and compact. It's in a 19-in. standard rack about 30 in. high with the operator's terminal sitting on top of the rack. The Plotter and fathometer are the only outboard units. Our small 11-in. Houston Instruments Plotter may be used if desired.

The new field system software is essentially the same as the original with much more capability. We have in the new survey system a remote tracking capability. This will allow our 65-ft mother vessel to track, in X and Y coordinates, the position of a mobile transponder located in a small survey fathometer skiff using the mother vessel's computer, ranging equipment, and tape recorders. Then digitizing the fathometer scroll or having a digital fathometer with a tape recorder and combining the two tapes in-house, a survey will appear to have been made in the normal, automated way. Likewise, the mobile transponder and battery could be placed in a truck or on a man's back with the same tracking capability. For instance, a man running a level, and the rodman with the mobile transponder and battery on his back could define a shoreline, establish X-sectional elevations on a disposal area, or do other types of topographic work that while being acquired, is recorded in X, Y, and Z coordinates on the mother vessel. (Z data are sent by radio to the mother vessel for manual insertion in the tape recorder.) An in-house computer program can then plot or otherwise use these data to supplement a hydrographic survey or to supply plotted topographic data. We also have an onboard postplot routine that can plot the tide-reduced depth data as acquired along the track of the boat. Although of little use in a contract situation due to the random positions of each sounding and the unedited, unverified depth data, the postplot function will allow rapid presentation of rough data to a government plant, such as a hopper or sidecasting dredge, or an initial plot of an area for preliminary usage. Postplotting is also time-consuming and requires people with mapping expertise not generally found with field survey units. And right here is probably one of the major management problems facing a District when trying to incorporate a survey system into its survey effort--who does what! when! Without intimate, productive cooperation between the various departments (field surveys, office mapping, computational sections, ADP, and others), the survey system as a tool for a District will be worse than useless. Wilmington District has surmounted this problem in that for the last 4 years we have surveyed, mapped, computed, and paid contractors based totally on data our survey system acquired and processed.

As I said earlier, it is hard to separate the field and in-house survey systems. I have already covered some of our software developments and background necessary to develop software routines to accomplish the desired task. Let us now look at our in-house system.

Our software programs are designed to be as technician/operator independent as is possible; also this is the objective of the field (hardware) systems such as Motorola, Del-Norte, ..., Data Logger. In the area approach to surveys all survey jobs look exactly alike, thus input, both field and office, can be reduced to the absolute minimum. With our Tektronix Graphics Terminal and new minicomputer system, all our programs are being redesigned to further reduce and simplify technician/operator input and control. Program selection and data input will be in response to computer requests. All programs will be self-loading and each succeeding program will be automatically called as required for finished results. Our new operating system, not yet fully developed or operational, will look like this (slide).

Raw data tapes will enter the system to disk storage. The technician will then call the raw data and the survey edit program. The survey edit program will then call for channel control data, control line starts and stops, and X-section interval and tide table if not applied in the field. Incidentally, channel control data may differ significantly between the office and the field. In the field, channel survey control generally follows the center line of the channel or area to be surveyed. The office channel control may be the center line of a channel baseline or any other line that may be desired. Also the same survey may be plotted several times with different control lines. All office data are presented in X-section from 90° to a selected control line, because it is easier to read and also that is how volumes are computed. The edit program will display on our Tektronix Graphics Terminal the track of the boat as it acquired the data. Programmed edit capability will check and eliminate all error-flagged data generated by the field system. (Bad range data will set X and Y coordinates to zero.) Technician edit capability will eliminate any obvious positional data units. When this is completed, the bottom profile as acquired will be displayed. Programmed editing will consist of elimination of soundings that fall outside a preset gate (similar to that of the field units fathometer gate).

Next will be a plotted display of the raw data overplotted on the edited data, for both the track of boat and bottom profile, to be sure nothing was changed that was not desired. The edit program will then adjust all soundings for squat and tide. (A squat curve was generated when we acquired our survey vessel.) At this point the data file will be "change protected" to become a library file for retention as long as desired. Subsequent runs of this file will allow only channel control data changes as desired by an interested department technician.

The edit program will then call in the X-section generator.

Changes of original control data may be made if desired.

X-sections are generated by rotating all field data coordinates into stations and offsets based on the control line, with the first X-section 90° to the start of this line. Soundings are interpolated (straight line interpolation) from two consecutive soundings that span a cross-section line at each X-section interval along the track of boat as the data were originally acquired. In our current program, as many as 50 X-sections containing up to 80 soundings may be acquired from a single pass through a data tape. Each X-section is then sorted in ascending order to facilitate further use.

The X-section generation program will automatically call in the X-section edit program. This program will display on the Tektronix Graphics Terminal each X-section individually. X-section edit and technician change is provided to eliminate any final obvious errors in depth. This file of edited X-section data is then stored either temporarily or permanently for other departments. From this point a technician must select the next program, map plot, or quantity computations. The mapping section will select map plot, enter the scale, sheet orientation, direction of increasing stations, number of channel segments on map sheet to be plotted, and plot limits and other map control data necessary to plot the survey as they want it. A map plot tape will be delivered to them from ADP for plotting on a Calcomp Flatbed Plotter. This is just a straightforward plot package using control data supplied and generating a plot tape. Plotting field surveys on predrawn sheets has presented some real problems, namely, scale control. Our plotter is accurate to 0.005-in.; our predrawn, reproduced maps are not. Also keeping up with master sheets and reproduced copies is burdensome, so we are just beginning to accumulate a library file of digitized master sheets of all our channels. Each sheet will be identified with the same numbering system we use on the field surveys, and will be called for plotting at the time that sheet is needed to plot a survey.

If the quantity computations program is selected, the technician will enter cut control data as required, start and stop station of cut, and offset limits of both sides of cut. This is an adaptation of our first quantity program to accept data from a disk rather than from cards. Quantities are computed to three selected depths with any selected side slope on either side of the cut. Volumes are given between each consecutive station and also accumulated for a total.

In our systems approach, one or more people may be involved in processing a survey. One technician will usually handle a particular job from raw data to map plot; another technician will compute quantities. All of our projects are identified by their F&A number. Then smaller components of that project are identified by another unique number, both permanent. These numbers with the date or dates of any survey will uniquely identify all surveys and simplify locating and retrieving.

In summary, data processing is an important part of our survey system. The field system generates mountains of data which can be utilized only by a computer. Effective use must depend on reducing all these data into a form usable by the different interested departments. Planning and developing an efficient in-house data-processing system accomplishes this and thus becomes an integral part of the field automated survey system.

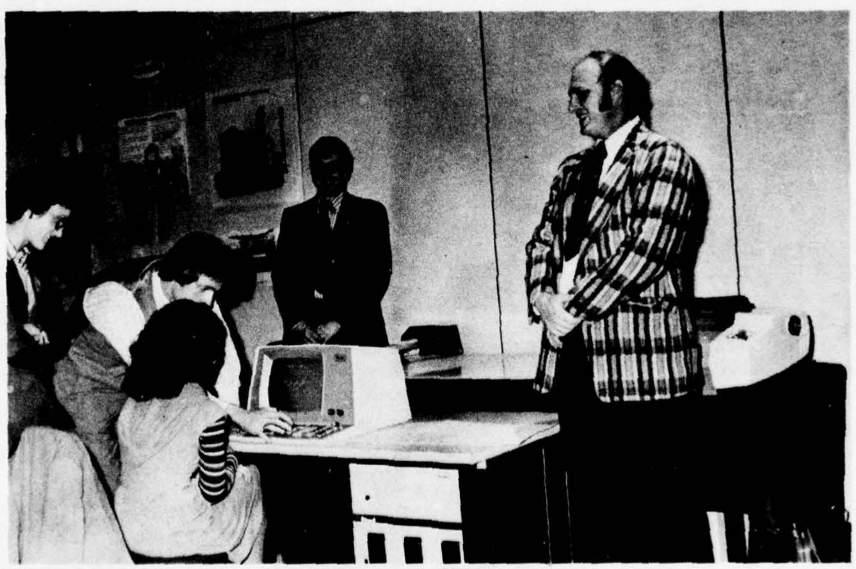
INFORMAL SESSION

MANUFACTURERS' PROGRAM

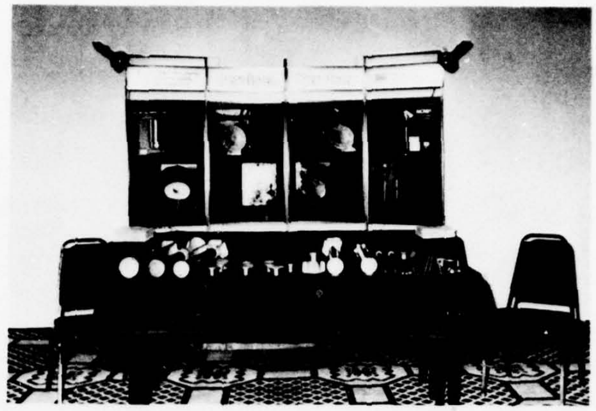
The manufacturers' program was conducted in two parts: in-house exhibits and field demonstrations. The private firms were invited to attend to ensure that Corps survey personnel were familiar with the latest available hydrographic surveying equipment. Thirty-one private firms participated during the afternoon of 8 November and all day on 9 November. The firms, their product or service, contact, address, and telephone number are listed in Appendix D.

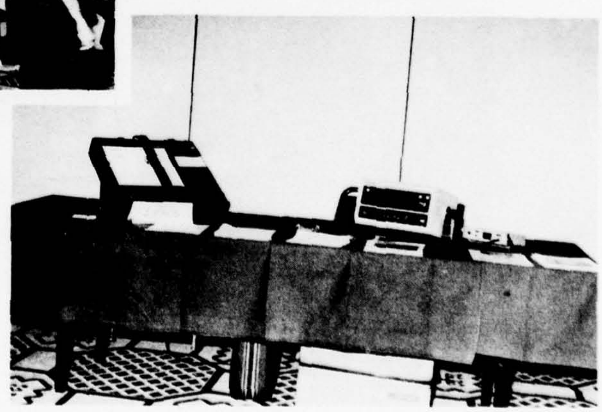
IN-HOUSE EXHIBITS

The exhibits were made in the Stratford and York Halls of the OMNI International Hotel. Individual exhibit space was provided for each firm. The conference attendees were divided into three groups and assigned a formal half-day period for visiting the exhibit area. Additional time was spent with the manufacturers at the attendees discretion.



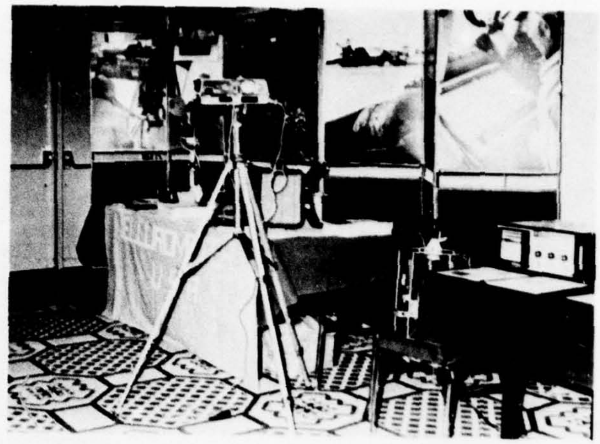
IN-HOUSE EXHIBITS...

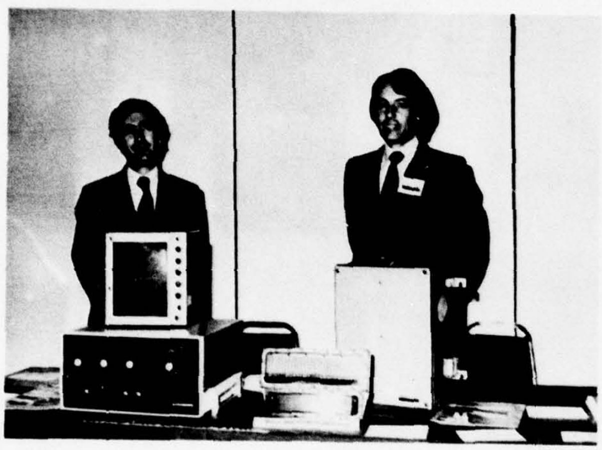




...IN-HOUSE EXHIBITS

IN-HOUSE EXHIBITS...





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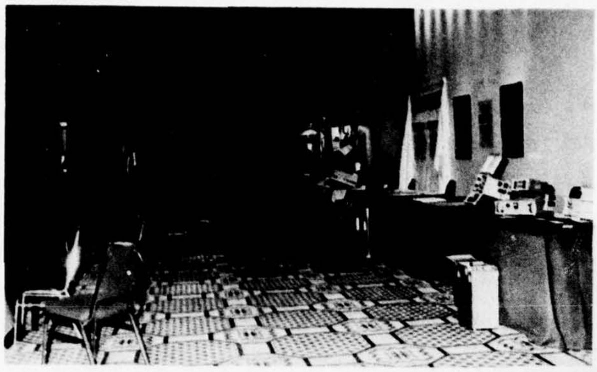
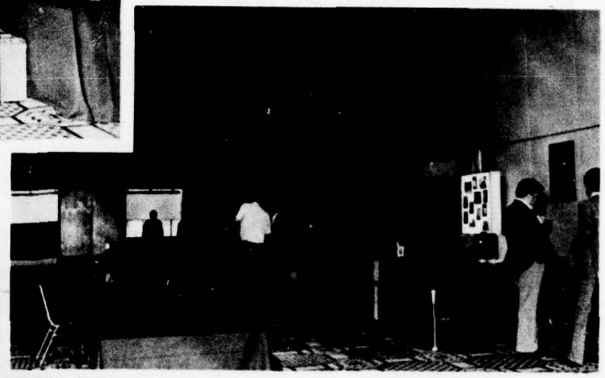
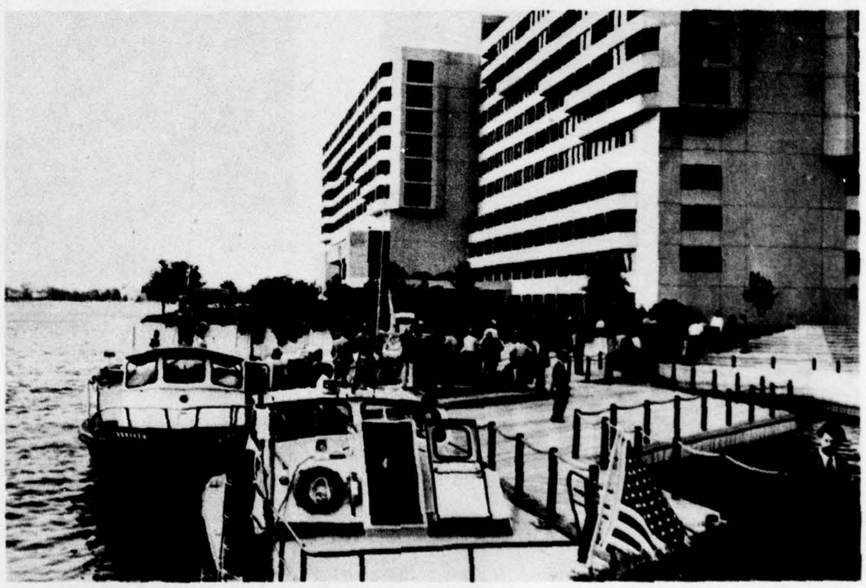


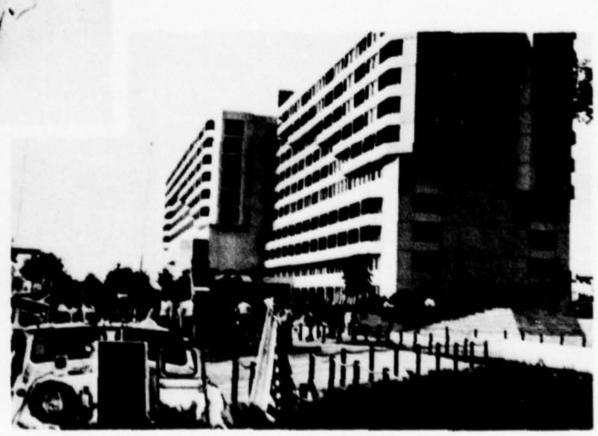


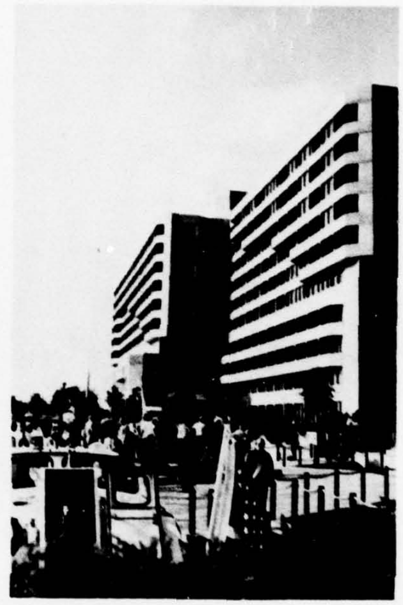
FIELD DEMONSTRATIONS

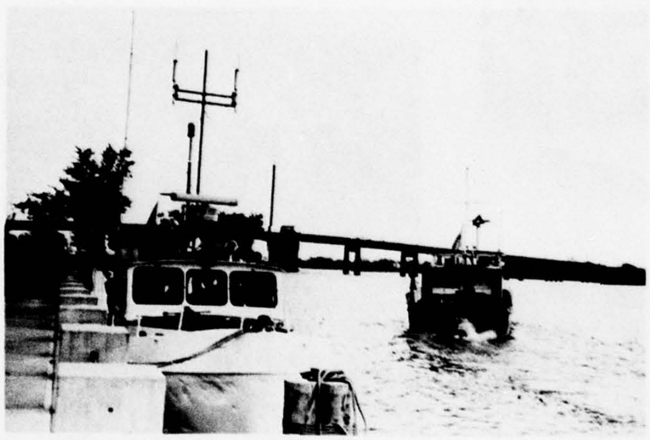
Six boats were available for live demonstrations of survey equipment. Three survey boats were provided by the Norfolk District, and one each by the Baltimore District, NOAA, and MonArk Boat Company (see Appendix D). Attendees boarded the boats at a landing situated adjacent to the OMNI Hotel. As with the in-house exhibits, the assigned groups each spent a half-day observing these demonstrations.

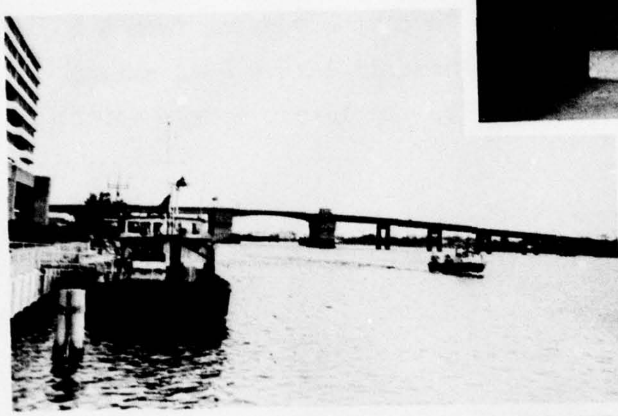
Motorola, Inc., demonstrated its system aboard the MonArk boat. NOAA personnel conducted surveys with their newly developed General Instrument Corporation Bathymetric Swath Surveying System aboard their survey boat LAIDLEY. Companies demonstrating aboard the four Corps boats were Tellurometer, Hydrocarta, Ocean Research Equipment, Plessy Environmental, Ross and Teledyne Hastings-Raydist. Photographs of the field demonstration activities follow.

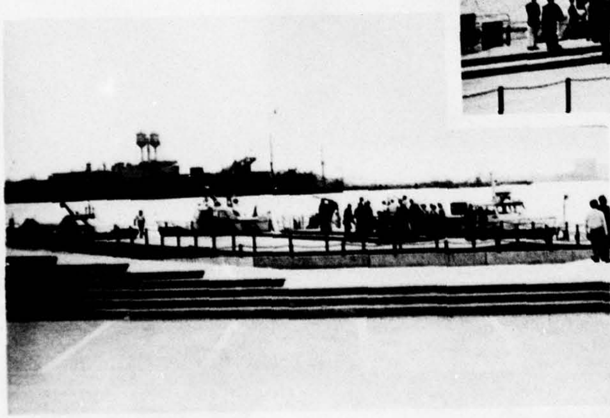


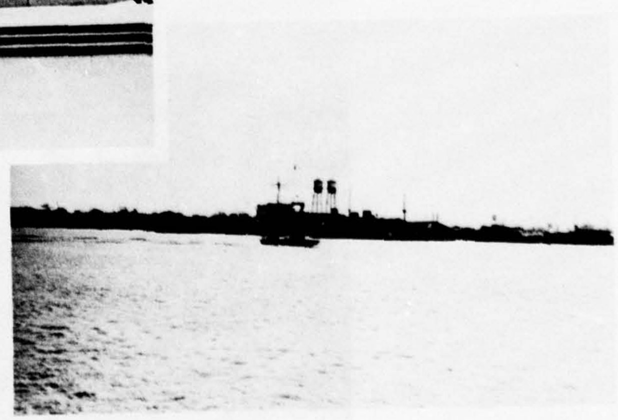






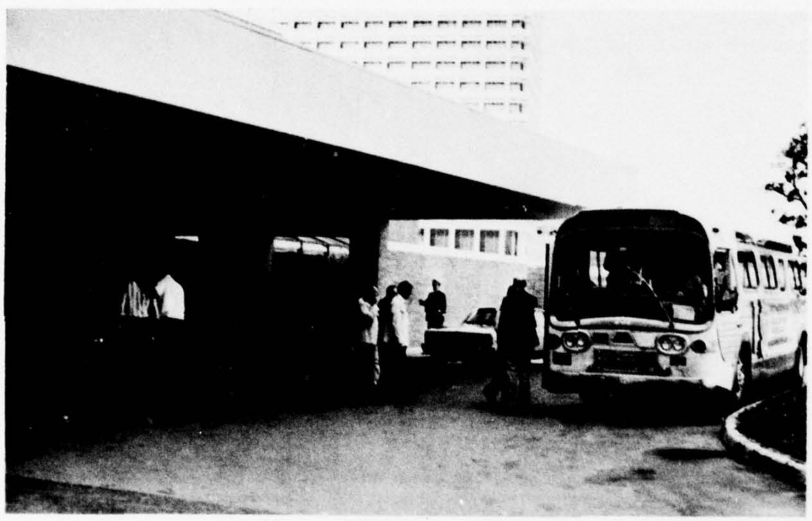


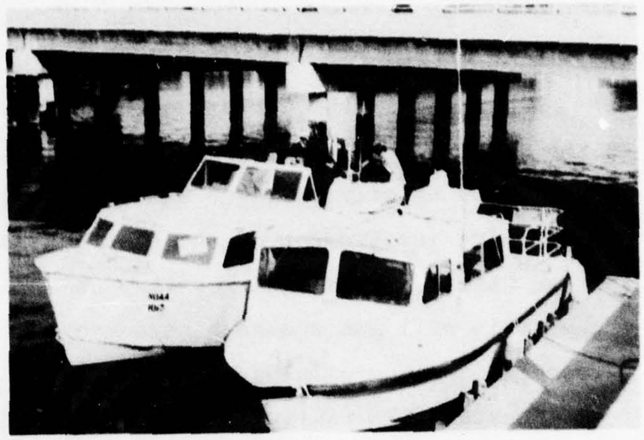




NOAA ATLANTIC MARINE CENTER (AMC)

The attendees were bussed by groups to the AMC for a tour of the NOAA facilities. The program included a tour of an earlier generation computer center as well as the latest system which was being installed. Methods and results of plotting underwater topography from aerial photographs were presented. Plots were made in depths varying from 4 to 40 ft, dependent upon water conditions. Formerly active NOAA survey boats were shown to the attendees as well as the latest models which were being outfitted.

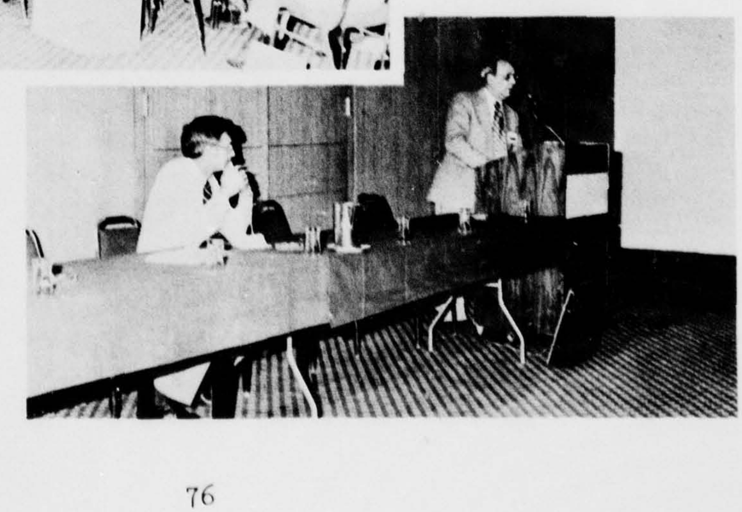




BUSINESS MEETING

A meeting of the Corps and other government personnel was held on the morning of 9 November. Mr. M. Millard, OCE, presided at the meeting. He briefly reviewed some existing and new Corps programs which will require involvement of the District survey people. These included the Dam Safety, Streambank Erosion, and Beach Erosion programs. Although this will put a strain on surveyors, the outlook for additional personnel is not promising.

Considerable time was devoted to discussing a need for a uniform grade structure for Corps hydrographic surveyors. From comments it appears there is a wide range of grades for a party chief, the grade set being dependent upon the individual District classifier. Mr. Millard said he would continue to work on this problem. He asked that job descriptions of GS-09 and GS-11 hydrographic survey party chiefs be sent to him to use as a guide. Photographs of the meeting are shown below.



APPENDIX A: MEMORANDUM ANNOUNCING CONFERENCE

DEPARTMENT OF THE ARMY
WATERWAYS EXPERIMENT STATION. CORPS OF ENGINEERS
P. O. BOX 631
VICKSBURG, MISSISSIPPI 39180

IN REPLY REFER TO: WESHP 29 September 1977

SUBJECT: Corps of Engineers Hydrographic Survey Conference, 8-9 November 1977

Division Engineers, U. S. Army Engineer Divisions, CONUS
Division Engineer, U. S. Army Engineer Division, Pacific Ocean
Division Engineer, U. S. Army Engineer Division, Middle East
District Engineers, U. S. Army Engineer Districts, CONUS

1. The Waterways Experiment Station (WES) has been assigned the responsibility of coordinating development and/or procurement among the CE field offices of modern, efficient hydrographic surveying systems. An important and effective phase of this assignment has been a biennial conference, initiated in 1972, which brings together surveying personnel from each Corps office. Private vendors have presented their hydrographic surveying equipment at each of these meetings. The net result has been an efficient and accelerated Corps program of procuring and using modern hydrographic surveying systems. Experience with the new equipment and knowledge gained at the conferences have resulted in considerable savings in the Corps surveying program.

2. Because of the favorable response to the conferences and actions taken by the districts and divisions, it has been determined they should be continued. This will permit a continuing exchange of ideas, methods, and experiences of Corps surveying personnel. Several Corps offices have leased and evaluated integrated systems and other components since the last conference. The experience and knowledge thus gained will provide valuable information for others.

3. The conference will be held on 8-9 November 1977 in the Norfolk District at the OMNI Hotel. The conference agenda is inclosed. A portion of the first day will consist of presentations and discussions of hydrographic equipment, experiences, and problems. The remaining time will be devoted to equipment exhibits, field demonstrations, and a Corps business meeting.

4. The conference will be most beneficial if as many districts and divisions as possible can be represented. The Office, Chief of Engineers, recommends that each district and division send at least one member from their hydrographic surveying group. To further ensure the success of the conference it is requested that departing flights be scheduled after 6:00 p.m. on 9 November 1977.

WESHP 29 September 1977
SUBJECT: Corps of Engineers Hydrographic Survey Conference, 8-9 November 1977

5. Adequate lodging is available at the OMNI. Because of the rates (single $24-$32, double $32-$40) some may desire to "double-up." Limousine ($3.25 one way) or taxi service can be used from and to the airport. Advance information or assistance such as city maps, reservations, etc. may be obtained through Miss Cheryl A. Lunn of the Norfolk District Public Affairs Office (telephone number FTS 924-3606 or 804-446-3606). For monitoring purposes it is requested that all lodging reservations be made through the Norfolk District. Further details concerning the conference may be obtained by calling Mr. E. D. Hart (FTS 542-2258 or 601-636-3111, Ext 2258) or Mr. G. C. Downing (FTS 542-2747 or 601-636-3111, Ext 2747) of WES.

1 Incl
as

JOHN L. CANNON
Colonel, Corps of Engineers
Commander and Director

APPENDIX B: CONFERENCE ATTENDEES

Corps/Agency	Personnel
Corps	
Office, Chief of Engineers, CE	Manning, E. C. Millard, M.
New England Division	Donovan, F. Guptill, H. Hamilton, R. Ober, T.
North Atlantic Division	Beechley, B.
Pacific Ocean Division	Kalino, V.
Alaska District	Adams, B. J. Millet, L. G.
Baltimore District	Auter, W. Bunting, W. Lowery, B.
Buffalo District	LaFountain, J.
Charleston District	Jennette, N. W. Linbaker, F. L.
Chicago District	Hauck, R. E. Wagman, E.
Detroit District	Bagalay, R. R. Barnes, R. C. Gauthier, R. L. Lamphere, C. E. Simpson, M.
Ft. Worth District	Morrow, F. B
Huntington, District	Applegate, R. R. French, S. Huffman, G.
Jacksonville District	Pruett, J. C.
Kansas City District	Brown, D. Burke, T. Vanhaverbeke, M.
Los Angeles District	Anderson, H. Wood, J. E.
Louisville District	Connor, M. Beck, B.
Memphis District	Kilmore, D. R. Wilkerson, A. L.

(Continued)

Corps/Agency	Personnel
Corps(Continued)	
Mobile District	Bedsole, T. Thrower, D. Wells, R.
Nashville District	Davis, H. M.
New Orleans District	Cambre, R. F. Tobelman, C. D.
New York District	Elmore, R. V., Jr. Muszak, W. F.
Norfolk District	Aaron, W. L. Cox, R. M. Ewell, D. L. Goodwin, Z. M. Jarvis, A. D. Kelley, M. J. Kyker, A. Miles, M. K. Moses, R. T. Parker, L. E. (Retired) Pruhs, J. H. (Retired) Pruhs, R. Sweitzer, R. Vann, R. G. Walsh, J. A.
Omaha District	Brown, R. W. Christian, H. E.
Philadelphia District	Spies, H. R. Wagner, B.
Pittsburgh District	Schmidt, F. Taylor, T. E.
Portland District	Hopman, R. Sing, D. West, N. H.
Rock Island District	Crittenden, J. L. Gilmore, M.
St. Louis District	Brown, G. N. Derrick, R. Graf, E. E. Houston, D. Krah, B. Long, N. C.

(Continued)

Corps/Agency	Personnel
Corps (Continued)	
St. Louis District (Continued)	Olson, P. Page, L. Turlin, C. L.
St. Paul District	Kletzke, G. S.
San Francisco District	Bruch, T. Dickson, W. J.
Savannah District	Bell, D. R. Ricks, O.
Seattle District	Maresh, H. Parker, R.
Tulsa District	Hartwell, H.
Vicksburg District	Brooks, J. H. Sykes, R. J.
Wilmington District	McCoy, O. J. Holliday, B. W.
U. S. Army Coastal Engineering Research Center	Prins, D.
U. S. Army Engineer Topographic Laboratory	Cotman, H. Messmore, J. A. Robertson, K.
U. S. Army Engineer Waterways Experiment Station	Downing, G. C. Hart, E. D.
Other U. S. Government	
Bureau of Land Management	Healy, J. E.
Coast Guard Research & Development Center	Lindeblad, J. Pike, C.
Defense Mapping Center Cheyenne, Wyo.	Witter, B. H.
National Oceanographic and Atmospheric Administration	Atwell, J. T. Bloom, J. Cabaniss, E. Corndius, R. Daniels, W. R. Dinkle, C. Efird, J. Elliott, D. Faulkenberry, B.

(Continued)

Corps/Agency	Personnel
Other U. S. Government (Continued)	
National Oceanographic and Atmospheric Administration (Continued)	Holden, K. Hopkins, R. D. Jones, R. W. Kennedy, J. Krebs, M. S. McCaffrey, E. K. Mobley, W. L. Munson, R. C. Nixon, C. H. Pardue, A. Riddick, F. Shea, J. D. Sowers, J. Sunocki, R. D. Wallace, J. Winslow, T.
Tennessee Valley Authority	Sheridan, W. M.
U. S. Coast Guard	Anthony, J. J. Holmdohl, G. R. Horton, G. Schroeder, K. Wrarala, T. R.
U. S. Geological Survey	Adsit, R. R.
U. S. Naval Explosive Ordnance Disposal Facility	Pedersen, A.
U. S. Naval Oceanographic Office	Johnston, J. Morton, M. R. Taylor, P. Woodson, H.
Foreign and Nongovernment	
Atomic Energy Research Establishment, United Kingdom	Ward, L.
Dept. of Transportation, Canada	Jones, D.
Marconi Space & Defense Systems, United Kingdom	Napier, D. Pearce, R.
Marine Technology Support Unit Aere Harwell, United Kingdom	Wood, L. D.
Venezuela	Perez, C.
Waterway Surveys & Engineering, Ltd.	Holton, J. W., Jr.
Sea Technology Arlington, Va.	Bussmann, C. A. Mulcahy, M.

APPENDIX C: CONFERENCE SCHEDULE

CORPS OF ENGINEERS FIFTH HYDROGRAPHIC SURVEY CONFERENCE
OMNI Hotel, Norfolk, Virginia
8-9 November 1977

<u>Tuesday, 8 November</u>

8:00 a.m. Welcome, Zane Goodwin, Chief, Engineering Division, Norfolk District

8:10 a.m. Introductory Remarks, M. Millard, OCE, Conference Chairman

TECHNICAL SESSION (Providence Hall)
Session Chairman - A. L. Wilkerson, Memphis District

8:20 A.M. Don Thrower, Mobile District, "Trailerable Automated Survey Boat"

9:00 a.m. G. C. Downing, Waterways Experiment Station, "Precision Radar Navigation System"

9:50 a.m. BREAK

10:20 a.m. CPT Wayne Mobley, NOAA, Rockville, Md., "Bathymetric Swath Survey System and Its Potential for Effective Bottom Mapping"

11:10 a.m. Orval McCoy, Wilmington District, "Automated Survey System Data Processing"

12:00 noon Group Photograph

12:15 p.m. LUNCH

1:30 p.m. Group A - NOAA Atlantic Marine Center Tour (Bus at OMNI Front Entrance)
Group B - Manufacturer Exhibits & Discussions (York and Stratford Halls)
Group C - Field Demonstrations (OMNI Boat Landing)

5:00 p.m. Group A - Return to OMNI Hotel

6:00 p.m. RECESS

<u>Wednesday, 9 November</u>

8:00 a.m. Corps Executive Session, M. Millard, presiding (Other government attendees welcome)

9:00 a.m. Group A - Manufacturer Exhibits and Discussions
Group B - Field Demonstrations
Group C - NOAA AMC Tour

12:00 noon Group C - Return to OMNI Hotel

12:15 p.m. LUNCH

1:30 p.m. Group A - Field Demonstrations
Group B - NOAA AMC Tour
Group C - Manufacturer Exhibits & Discussions

5:00 p.m. Group B - Return to OMNI Hotel

6:00 p.m. ADJOURN

NOTES: (1) Individual photos of attendees will be made as time allows in Providence Hall. (2) Group A: Alaska - Little Rock Districts; Group B: Los Angeles - Portland Districts; Group C: Rock Island - Wilmington Districts and all Divisions. (3) Other agency representatives will be given group assignments at the conference.

APPENDIX D: SUPPLIERS OF HYDROGRAPHIC EQUIPMENT OR SURVEY SERVICES REPRESENTED AT THE CONFERENCE

Company Name	Person to Contact	Product or Service
Ametek/Straza 790 Greenfield Drive El Cajon, CA 92021	J. Harford Rockville, MD 305/521-4106	Doppler Navigators Marine Equipment
AVCO-Everett 2385 Revere Beach Parkway Everett, MA 02149	Condon McDonough 617/389-3000	Laser Depth Profiling
Bernsten Cast Products Box 3025 Madison, WI 53704	William B. Garrett 608/249-8549	Land Survey Monuments
Cubic Western Data 5650 Kearny Mesa Road P. O. Box 80787 San Diego, CA 92138	C. B. Hempel 714/279-7400	Distance-Measuring Equipment Electronic Survey Systems
Decca Survey Systems, Inc. P. O. Box 22397 Houston, TX 77027	Earl Smith 713/783-8220	Distance-Measuring Equipment Electronic Survey Systems Contract Surveys
Del-Norte Technology, Inc. P. O. Box 696 Euless, TX 76039	Jim Stegall 817/267-3541	Distance-Measuring Equipment
EPSCO Marine Navigation Products 411 Providence Hwy Westwood, MA 02090	Lou Stadlin 804/723-7889	Loran-C Plotter
General Instrument Corp. Harris ASW Division 33 Southwest Park Westwood, MA 02090	Jack Capell 617/326-7815	Marine Equipment Underwater-Scanning Systems
Hewlett-Packard 1820 Embarcadero Road Palo Alto, CA 94304	Lawson Deaton 919/885-8101 Regional Sales Office P. O. Box 5188 High Point, NC 27262	Land Survey Equipment
Hydrocarta Corp. 9730 Town Park Drive Houston, TX 77036	Colin G. McQ. Weeks 713/771-1263	Positioning Equipment Electronic Survey Systems Contract Surveys

AD-A055 031 ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MISS F/G 8/8
HYDROGRAPHIC SURVEY CONFERENCE (5TH) 8-9 NOVEMBER 1977,(U)
MAR 78 E D HART, G C DOWNING

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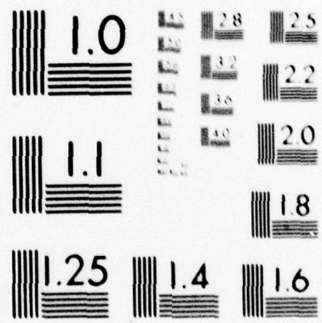

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Company Name	Person to Contact	Product or Service
HydroLab P. O. Box 9406 Austin, TX 78766	Jim Flynn 512/837-2050	Environmental Monitoring Equipment
Innerspace Technology, Inc. 27 Frederick St. Waldwick, NJ 07463	Stephen Holowacz 201/447-0398	Depth Digitizers Subbottom Profilers
JMR Instruments 20621 Plummer St. Chatsworth, CA 91311	John Ellison 213/882-2800	Marine Equipment
Kilbane Software Consultant 61 Chester Road Belmont, MA 02178	J. C. Kilbane 617/484-0736	Software Support
Klein Associates, Inc. Route 111, RFD 2 Salem, NH 03079	Martin Klein Gene Schartz 603/893-6131	Side Scan Sonar
Marconi/AMF Sea Link Systems 3001 Centerville Rd. Herndon, VA 22070	Peter Moon 703/471-3222	Navigation Systems Mini-Sonar
Martek Instruments, Inc. 879 W. 16th St. Newport Beach, CA 92660	Ben Cameron 714/540-4435	Environmental Monitoring Equipment
MonArk Boat Co. P. O. Box 210 Monticello, AR 71655	J. H. Smith 501/367-5361 -6236	Survey Boats
Morgan Consulting, Inc. 357 N. Eglin Parkway Ft. Walton Beach, FL 32548	John Morgan 904/242-1413	Depth Data Loggers Microprocessor Navigation Systems
Motorola, Inc. Government Electronics Div. 8201 E. McDowell Rd. Scottsdale, AZ 85252	Dick Lambson Dick Speilman 602/949-3181	Distance-Measuring Equipment Electronic Survey Systems
Ocean Research (ORE) P. O. Box 709 Falmouth, MA 02541	Dave Porta 617/548-5800	Sub-Bottom Profilers Side Scan Sonar

Company Name	Person to Contact	Product or Service
Plessey Environmental Systems P. O. Box 80845 San Diego, CA 92138	G. N. Clausen 714/278-6500 Jerry Blakely/ Rick Stephens 301/946-0082	Environmental Equipment
Raytheon Corporation P. O. Box 360 Portsmouth, RI 02871	Bill Adams John Donnelly 401/847-8000	Depth Measuring Equipment
Riley, Park, Hayden & Assoc., Inc. 136 Marietta Street, NW Atlanta, GA 30303	Ralph L. Hayden 404/577-5600	Contract Surveys
Ross Laboratories, Inc. 3138 Fairview Ave., E. Seattle, WA 98102	Wayne Ross 206/324-3950	Depth Measuring Equipment
Sercel, Inc. Suite D10 4800 W. 34th Street Houston, TX 77018	John L. DeVault 713/688-9433	Electronic Navigation Equipment
Sperry Marine Systems Sperry Rand Corporation Route 29 N Charlottesville, VA 22901	Mort Howard Great Neck, NY 516/574-1502	Doppler Navigators Gyrocompasses Depth Sounders
Teledyne/Geotech 314 Montgomery Street Alexandria, VA 22314	Bill Whyte 703/836-3882	Electronic Survey Systems
Teledyne/Raydist P. O. Box 1275 Hampton, VA 23361	J. W. Newsome 804/723-6531	Electronic Distance-Measuring Equipment
Tellurometer Division Plessey Electronics Corp. 89 Marcus Boulevard Hauppauge, NY 11787	Ron Baronello 516/231-7710	Electronic Distance-Measuring Equipment Land Surveying Equipment
Wang Laboratories Suite 404 Denbigh Professional Park 606 Denbigh Boulevard Newport News, VA 23602	Sam Narkinsky 804/874-8005	Data-Processing Equipment

APPENDIX E: CORPS OF ENGINEERS HYDROGRAPHIC SURVEY CONTACTS, JANUARY 1978

District	Name	FTS No.	Commercial No.	Address	Zip
Lower Mississippi Valley Division					
Memphis	A. L. Wilkerson	222-3238	01/521-3610	668 Clifford Davis Federal Building	38103
St. Louis	C. E. Myers	278-2833	314/268-2833	210 N. 12th St.	63101
Vicksburg	E. L. Howe	542-6502	601/636-1311	P. O. Box 60	39180
New Orleans	W. Weiser	687-1121	505/865-1121 (Ext 416)	P. O. Box 60267	70160
Southwestern Division					
Galveston	A. Graham, Jr.	527-6366	713/763-1211 (Ext 366)	P. O. Box 1229	77550
Little Rock	T. S. Cook	740-5679	501/378-5679	P. O. Box 867	72203
Little Rock (Dardanelle Res)	T. Spencer	--	501/968-5008	P. O. Box 1087 Russellville, Ark.	72801
Albuquerque	E. H. Lassen	474-2615	505/766-2615	P. O. Box 1580	87103
Tulsa	T. Willard	736-7203	918/581-7203	P. O. Box 61	74102
Tulsa (Kerr Res)	C. E. Weddle	--	918/775-4475	Star Route 4, Box 182 Sallisaw, Okla.	74955
Ft. Worth	F. B. Morrow	334-2210	817/334-2210	P. O. Box 17300	76102
Ohio River Division					
Pittsburgh	T. E. Taylor	722-6826	412/644-6826	Federal Building 1000 Liberty Ave.	15222
Huntington	R. R. Applegate	924-5698	304/529-5698	P. O. Box 2127	25721
Huntington	S. K. French	924-5239	304/529-5239 (or 5684)	P. O. Box 2127	25721
Louisville	M. Berkman	352-5720	502/582-5720	P. O. Box 59	40201
Nashville	H. M. Davis	852-5607	615/251-5607	P. O. Box 1070	37202
Nashville	J. W. Hall	852-5954	615/251-5954	P. O. Box 1070	37202

(Continued)

District	Name	FTS No.	Commercial No.	Address	Zip
			Missouri River Division		
Omaha	H. E. Christian	864-4020	402/221-4020	P. O. Box 6014 215 N. 17th St.	68102
Kansas City	T. Burke	758-3341	816/374-3341	700 Federal Building 601 E. 12th St.	64106
			New England Division		
Waltham, Mass.	F. Ciccone*	829-2330	617/894-2400	424 Trafelo Road	02154
Waltham, Mass.	D. Sullivan	829-2351	617/894-2400	424 Trafelo Road	02154
			South Atlantic Division		
Wilmington	O. McCoy	674-9449	919/763-9971 (Ext 449)	P. O. Box 1890	28401
Mobile	J. I. Meredith	534-2576	205/690-2576	P. O. Box 2288	36628
Savannah	O. Ricks	248-8373	912/233-8822 (Ext 373)	P. O. Box 889	31402
Charleston	I. B. Kyzer	677-4366	803/577-4171 (Ext 366)	P. O. Box 919	29402
Jacksonville	J. C. Pruett	946-2434	904/791-2434	P. O. Box 4970	32201
			North Atlantic Division		
New York	W. F. Muszak	264-0181	212/264-0181	26 Federal Plaza	10007
Baltimore	H. Epstein	922-3663	301/962-3663 (or 3664)	P. O. Box 1715	21203
Norfolk	R. A. Pruhs	924-3664	804/446-3664	803 Front St.	23510
Philadelphia	H. R. Spies	597-4745	215/597-4745	U. S. Custom House 2nd and Chestnut St.	19106

(Continued)

* Mr. Ciccone will be leaving soon and a new chief has yet to be appointed.

District	Name	FTS No.	Commercial No.	Address	Zip
		North Pacific Division			
Alaska	O. Smith	399-0150**	907/752-4341	P. O. Box 7002 Anchorage	99510
Portland	N. H. West	423-6301	503/221-6301	P. O. Box 2946	97208
Seattle	H. Maresh	399-3413	206/764-3413	P. O. Box C-3755	98124
Walla Walla	B. Kress	442-550	509/525-5500 (Ext 627)	Building 602, City-County Airport	99362
		South Pacific Division			
Los Angeles	E. M. Bratcher	798-5550	213/688-5550	P. O. Box 2711	90053
Sacramento	H. E. Windham	448-3364	916/440-3364	650 Capitol Mall	95814
San Francisco	W. J. Dickson	556-2404	415/556-2404	211 Main St.	94105
		North Central Division			
Buffalo	J. LaFountain	473-2454	716/876-5454 (Ext 2285)	1776 Niagara	14207
Chicago	R. Linden	353-6432	312/353-6432	219 S. Dearborn St.	60604
Detroit	C. E. Lamphere	226-6816	313/226-6816	P. O. Box 1027	48231
Rock Island	J. L. Crittenden	360-6268	309/788-6361	Clock Tower Building	61201
St. Paul	G. Kletzke	725-7544	612/725-7544	1135 USPO & Custom House	55101
		Office of Chief of Engineers			
	M. Millard		900/693-6984	HQDA (DAEN-CWO-M) Washington, D. C.	20314

(Continued)

** Seattle operator.

District	Name	FTS No.	Commercial No.	Address	Zip
			Waterways Experiment Station		
	G. C. Downing	542-2747	601/636-3111 (Ext 2747)	P. O. Box 631 Vicksburg, Miss.	39180
	E. D. Hart	542-2258	601/636-3111 (Ext 2258)	P. O. Box 631 Vicksburg, Miss.	39180
			Coastal Engineering Research Center		
	D. A. Prins	325-7145	202/325-7145	Kingman Bldg. Ft. Belvoir, Va.	22060
			Topographic Laboratory		
	K. D. Robertson	703/664-6194	202/664-6194	Research Inst. Ft. Belvoir, Va.	22060

In accordance with letter from DAEN-RDC, DAEN-ASI dated 22 July 1977, Subject: Facsimile Catalog Cards for Laboratory Technical Publications, a facsimile catalog card in Library of Congress MARC format is reproduced below.

United States. Army. Corps of Engineers. Hydrographic
  Survey Conference.
  Proceedings. 1st-
1972-
Vicksburg, Miss. : U. S. Waterways Experiment Station.
    v. : ill. ; 27 cm.
  1st-   edited by E. D. Hart and G. C. Downing.
___ _____Supplement. 1-
Vicksburg, Miss. : U. S. Waterways Experiment Station, 1973-
    nos. : ill. ; 27 cm.
  No.1-   by G. C. Downing.

1. Hydrographic surveying -- Congresses. I. Hart, E. Dale, ed. II. Downing, George C. III. United States. Waterways Experiment Station, Vicksburg, Miss.
VK589.U5