

# **Continuing Development of the FIG/ Approved Category A “Master of Science Degree in Hydrographic Science” Program at The University of Southern Mississippi**

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The International Federation of Surveyors/International Hydrographic Organization (FIG/IHO) Category “A” certified Master of Science (M. S.) degree in Hydrographic Science (HS) Program established by The University of Southern Mississippi (USM) and the Naval Oceanographic Office (NAVOCEANO) is in its third year of operation. Twenty-two students have graduated from the HS Program with fifteen students in the current Class of 2002. All HS students in the first two classes entered the program through NAVOCEANO (civilian and uniform navy). They completed the non-thesis M.S. degree option in one intensive year of study that required two semesters of theory and one summer semester of practical application.

A new addition to the USM Stennis Space Center facilities is the Hydrographic Science Research Center (HSRC). The primary goal of the HSRC is to address NAVOCEANO operational hydrographic research needs. The HSRC compliments the HS program and will lead to excellent opportunities for graduate students who wish to do research and acquire a thesis based M.S. in Hydrographic Science.

As the HS program evolves and grows, it will continue to diversify to meet the needs of a wider range of clients among both the students and their potential employers. The purpose of this paper is: 1) to address the needs of an ever-expanding HS client base, 2) to briefly describe the current HS program at USM and its future plans, 3) and to explain how the cooperation between USM, NAVOCEANO and HSRC has enhanced the progress of the HS program in meeting the needs of an expanding client base.

## Introduction

Over the past several decades the traditional definition of hydrography has been expanded to better describe the reality of the evolving science. This evolution has been fueled by an increasing demand for hydrographic information, and by the changing technology used to collect, interpret and present that information. Consequently, those involved in the practice of hydrography must increase their knowledge base to keep up with modern technology and end user (client) needs.

Historically, the main products derived from hydrography have been nautical charts and related publications for the safety of navigation at sea. The primary clients for these products have been the maritime shipping and boating community. While these products and clients are still an essential component of modern hydrography, they no longer constitute the only component. Modern hydrographic data products include:

- Paper nautical charts and publications.
- Digital nautical charts and publications.
- Route survey engineering charts for pipelines and telecommunication cables.
- Geographic Information Systems (GIS) data related to coastal zone and resources management, e.g.:
  - Pollution control,
  - Fisheries management,
  - Habitat studies,
  - Resource management,
  - Erosion and Sediment transport studies,
  - Harbor Management,
  - Shipping Traffic Management Systems.

Not only are the applications for hydrographic data becoming more diverse, there is also an increasing demand for the integration of diverse data types (as in a GIS) as well as higher quality products based on higher resolution information.

Essentially, the modern hydrographer is tasked with collecting, processing, analyzing and disseminating all forms of marine related spatial information. Consequently, the modern hydrographer must be familiar with:

- Data collection methods such as:
  - Multibeam sonars,
  - Singlebeam echosounders,
  - Sidescan sonars,
  - Lidar,
  - Remote sensing,
  - GPS, DGPS and RTK GPS,
  - Data Mining (extracting alternate types of information from existing data).
- Processing methods such as:
  - Scanning, digitizing and image rectification,

- Remote sensing data interpretation,
- Sidescan sonar interpretation,
- Bathymetric (Multibeam, Singlebeam, LIDAR) data cleaning, interpretation and geo-referencing.
- Analysis Methods such as:
  - Merging of all related data into a single digital map for data registration and comparison.
  - Building of digital terrain models for 3D visualization, data editing and contour building.
- Final Products such as:
  - Hydrographic Databases.
  - GISs for:
    - Coastal Zone and resource management.
    - Oceanographic studies.
  - Paper (or raster) charts,
  - Electronic Nautical Charts (ENC),
  - Digital Nautical Charts (DNC),
  - Engineering Strip Charts.

In the past, many different individuals, usually in several different departments, with no one individual overseeing the entire process handled the processes mentioned above. With modern computer hardware and user-friendly software, more tasks are being assigned to multitasking (multitasked) individuals. In some cases, the process has come to the point where one individual can take a project from planning, through data collection and processing to final product with minimal assistance. This requires a very talented and well-educated individual.

Hydrographers are the key to creating the enhanced products demanded by a diverse group of clients. With today's rapid technology advancements it is not feasible – or desirable – to educate students with an emphasis on a particular piece of hardware or software. In many instances, technology is obsolete by the time the student must use it in the real world. If the education process emphasizes the concepts on which technology is based while using existing technology and processes to reinforce those concepts, then the learner can better adapt to new advancements in the real world.

Self-directed learning and life-long learning are two important concepts in the educational process. Many students gain far more from their learning experience by taking some ownership control of that experience. Also, if students learn to educate themselves, they will be better prepared to understand new concepts and technology long after leaving the learning institution. Former students can enhance the learning of current students by bringing their real experiences with new technology in the field, back to the classroom, thus contributing to a perpetual learning and upgrading process that benefits all involved. The rapidity of technology advancement has made it essential for professionals to constantly upgrade their skills and knowledge during their entire professional career.

This paper describes the HS program at USM. It discusses the philosophy of the program, how it is implemented to facilitate self-directed and life-long learning, and how the perpetual learning process is especially relevant. It also describes the relationship between the HS program, NAVOCEANO, and the HSRC, which enables USM to offer a unique hydrographic degree program with a combination of theory, practical application and exposure to new technology.

## **USM Hydrographic Science Degree Program**

### Overview

To facilitate the education of modern hydrographers, a hydrographic degree program should combine theory and practical experience with the most up-to-date technology and methods. This is a formidable task for one institution to attempt alone. The HS program of USM is in a unique and very favorable position in that it can draw on the technology and personnel resources of NAVOCEANO to augment the theory presented in the lecture portion of the program. When the HSRC is added to the mix, the result is an unparalleled center of excellence in HS education that provides students with theoretical background, practical experience and exposure to new technology and processes; all of which are necessary to be prepared for, and to excel in, the constantly evolving science of hydrography.

### Background

The HS program started as a joint venture between USM's Department of Marine Science (DMS) and NAVOCEANO. The first group of students graduated in August of 1999 and the second group in August of 2000. A total of twenty-two students have graduated with a Masters degree in Hydrographic Science. The program received Category "A" recognition from the FIG/IHO International Advisory Board on Standards of Competence for Hydrographic Surveyors in April of 2000.

In the first two years of the program, all of the students came from NAVOCEANO. The 2002 class consists of eleven NAVOCEANO personnel (nine civilian and two navy), two international students (naval officers from Peru and Tunisia), and one student each from the Army Corps of Engineers and the National Imaging and Mapping Agency.

### Facilities

The DMS is located beside NAVOCEANO headquarters at the Stennis Space Center in south Mississippi. The HS program classroom and offices are located in a separate building within walking distance of the DMS. This facility has seven offices, a library/map room, a processing/plotting room and a central classroom. Recently the DMS held a groundbreaking ceremony for their new hydrography and marine science laboratory complex, and plans are in the works for a cruise staging warehouse and more classroom and lab facilities.

## Matthew Fontaine Maury Oceanographic Library

With over 160,000 volumes of information, the Matthew Fontaine Maury Oceanographic Library, located at NAVOCEANO, contains the world's foremost military collection of physical oceanography materials. From modern CD-ROMs to handwritten 18th century ships' logs, the library is noted for the technical diversity of its holdings. It is a valuable resource for scientists in government, academic, and private industry.

Major collections, including journals, maps, charts, tide tables, books, technical reports, conference proceedings and translations, are in the field of oceanography with overlap into ocean engineering and marine technology. Other major areas represented include marine physics, international hydrography, chemistry, geology, biology, underwater acoustics, signal processing, geophysics, computer science and mapping. The library also carries materials relating to a variety of special interests, among them underwater photography, manned and unmanned submersibles, meteorology, marine geology, computers at sea, and biological, physical, and dynamic oceanography. All materials are entered into the Science and Technology Information Library Automation System (STILAS). Clients on and offsite may electronically dial into the library's databases to check availability and/or reserve material in circulation. The Maury Oceanographic Library catalog is also available via the Internet at <http://128.160.74.113>.

## Resources

The HS program has extensive resources at its disposal, most of these resources are owned by USM. The following list depicts the current status:

### HS (hardware)

- Individual Laptops for each student (1-Ghz Pentium III Dell Latitude Laptops).
- Two dual monitor/dual processor high-end workstations.
- 100+ Gb dedicated file server.
- HP 1055 plotter.
- 2 HP color Laser printers.
  
- 3 RTK/OTF ready Ashtech Extreme GPS receivers.
- 2 RTK/OTF ready Trimble MS750 GPS receivers.
- Trimble DSM212 DGPS beacon receiver.
- Knudsen 320M dual frequency singlebeam echosounder.
- Leica total station.
- 2 Leica digital levels.
- 2 Sutron tide gauges – each with pressure transducer and bubbler gauge.
- OTT float with encoder tide gauge.

### HS (Software)

- Entire CARIS Suite of Software:
  - CARIS GIS
  - HIPS and SIPS – Multibeam, Singlebeam and side-scan processing.
  - LOTS – Law of The Sea, marine boundary determination software.

- HOM – Hydrographic Object Manager for S-57 production.
- DOM – Digest Object Manager for DNC production.
- Area Based Editor – Multibeam data processing.
- Hypack Max– Hydrographic data collection, navigation and processing software.
- Fledermaus – 3-D data visualization software.
- ArcView – GIS.
- Matlab – math processing package.

## HSRC

- Benthos ROV for bottom sampling and underwater video.
- Marine Sonics Sea Scan dual frequency side scan sonar.
- Fully operational ECDIS lab.

## NAVOCEANO

- Bertram – Fully equipped multibeam and side-scan data collection and processing platform with:
  - Simrad EM3000 multibeam system.
  - POS MV.
- Experienced Hydrographers.
- Experienced instructors in HS.

## Program Outline and Design

Up to the present time, the most common degree completion stream has been to finish the degree requirements in one very intensive year of study. Classes start in mid-August and run until the end of July the following year. This schedule is not mandatory and students can distribute the course load over two or more years. For the purpose of this discussion, the one-year completion stream will be used as the model.

The program curriculum is closely based on the IHO publication M-5 “Standards of Competence for Hydrographic Surveyors”.

The year is broken up into three semesters:

- Fall semester:
  - Nautical Cartography and GIS.
  - Classical Geodesy.
  - Marine Geology for Hydrographers.
  - Math Concepts for Hydrographers.
  - Physical Oceanography.
  - Applied Ocean Acoustics.
- Spring Semester:
  - Hydrographic Data Management.
  - Law and Policy for Hydrographic Science.

- Kinematic Positioning.
  - Applied Bathymetry.
  - Remote Sensing for Hydrographers.
  - Water Levels.
- Summer Semester:
    - Nautical Science.
    - Practical Hydrographic Science.
    - Hydrographic Science Field Project.

The first semester is primarily theory and is intended to set up the theoretical base to support the following terms. The second semester is also theoretically based, but with some exposure to practical applications and fieldwork. The summer semester is mainly practical application of the theory presented in the previous two terms.

The Hydrographic Science Field Project is the last course taken by the students. It gives them the opportunity to put into practice all of the knowledge acquired from the previous courses. They are given almost complete control to design, plan, execute, process, and analyze this project.

Preparations for the summer field project start at the beginning of the first semester. In the Nautical Cartography and GIS course, the students select several candidate areas that would be suitable for the field project. The students are then divided into teams with each team being responsible for one of the candidate areas. Through a series of assignments and projects during the semester, each team develops a GIS for their designated area. They use all of the resources at their disposal to acquire as much spatially related information that they can find – shoreline, roads, facilities, soundings, navigation aids, tide information, horizontal and vertical control, satellite imagery, aerial photography, etc. This information is converted, transformed and registered in a GIS spatial database. From this database the students can create a paper chart or an ENC from existing data, and start to plan for the summer project.

At the beginning of the second semester, the students select one project area from the candidate areas. The practical aspects of Hydrographic Data Management, Applied Bathymetry, Kinematic Positioning, Remote Sensing and Water Levels are directed towards this project area. By the end of the second semester, much of the planning and preparation for the summer project has been completed, including:

- Horizontal and Vertical control verification and establishment.
- Tide gauge(s) establishment and tide monitoring.
- Reconnaissance and preliminary surveys.
- Extraneous data gathering (existing shoreline, aerial photography, etc).

Throughout the HS program, the students take more and more control over the decision-making process. By the time the summer field project begins, they are prepared to complete it with a minimum of instructor assistance. As students take more control of the decision making process, they also take more control and ownership of

the learning process. This fosters pride in ownership that leads to a far greater learning and understanding experience.

The final field project is the culmination of all of the learning achieved to this point. It gives the students the opportunity to apply all their previous learning in one major project. They are expected to plan, execute, process, analyze and present the results of a hydrographic survey, conducted for nautical charting purposes. Students are expected to build their own vessel-of-opportunity from the available HS resources, and they also have access to a fully operational multibeam survey vessel provided by NAVOCEANO. All HS faculty and staff are available for consultation, but all decision making and process execution is up to the participants.

Throughout the HS program, students are exposed to many tools of the hydrographic trade, both software and hardware. This program is not designed to train students on a particular piece of hardware or software. The intention is to use representative technology to reinforce concepts and give students the tools they need to complete the practical exercises. A student with sufficient theory and practical experience will be able to use almost any hydrographic software or hardware – new or old.

### **USM, NAVOCEANO and HSRC**

Students attending a technically oriented academic program should be exposed to the types of equipment used in what will become their profession. The theoretical concepts taught in the classroom must be reinforced by practical experience with real-world situations. Since it's beginning in 1999, the USM Masters in Hydrography Program has provided students this exposure and experience through assistance from NAVOCEANO. Equipment and survey vessel resources have been provided by NAVOCEANO as needed for classroom demonstrations and for the yearly summer hydrographic field survey. Knowledgeable instructors and computer laboratory facilities have been made available to instruct students in the use of equipment, specific equipment software, and more general purpose data collection and processing programs that are routinely used in actual NAVOCEANO hydrographic surveys.

The Hydrographic Science Research Center was established in February 2001 to monitor the constantly evolving technology in hydrography, and ensure the United States Navy implemented those advances in equipment and services that most improved its effectiveness and efficiency in hydrographic operations. The HSRC encompasses both the research and education components of this program in order to utilize complex resources presently available, adapting those resources to the Navy's needs, and training their staff in field application of these changing technologies.

The HSRC is chartered to assess new technologies for implementation into hydrographic operations. It currently focuses its research program based on the requirements articulated by the Naval Oceanographic Office (NAVOCEANO) and other agencies. HSRC activities are determined on a project-by-project basis after examining

existing technologies and determining what is needed to transition that specific technology to effectively solve previously identified NAVOCEANO problems. The role of USM-DMS Hydrographic Science personnel is to examine, implement, and train Navy personnel for use of those technologies developed by the Naval Research Laboratory, with the Office of Naval Research and NAVOCEANO as data recipients, and NAVOCEANO as the application provider. USM Hydrographic Science is responsible for mediation of research development and the application of the developed technology, implementing the technology and training NAVOCEANO staff to use and debug the technologies.

The hydrographic science faculty's philosophy is to implement the technology infrastructure as required, and develop technology as necessary if not available elsewhere. HSRC is funded to perform technology implementation tasks and take existing technology, and adapt, evaluate, and transition it for effective NAVOCEANO (and other agencies') use. The rationale for the technological development of the HS program is that technology can (a) improve the learning experience (learning technologies) for the students, and (b) familiarize the students with modern hydrographic technologies (e. g., multibeam equipment) they will encounter after graduation in their employment. NAVOCEANO's concerns must be met first with implementation of existing technology.

An educational program that combines theory, practical experience, research, up-to-date software and hardware and an effective learning environment is critical to the cultivation of the skilled hydrographers needed to meet the needs of an increasing and ever changing client base. It is the marriage of USM, NAVOCEANO and the HSRC that makes this HS program a success.