The Economic Benefit of Appropriate Education in Hydrography

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SUMMARY

The collection, processing and analysis of hydrographic data are highly technical processes requiring specialized training and education. Personnel lacking in appropriate skills may negate the validity of the information derived from a survey, leading to the need to re-survey; or even worse, leading to incorrect decision making based on faulty information. To build capacity it is necessary to develop suitable training. The costs in personnel and ship time surrounding hydrographic surveys are extensive. The economic impact of not completing adequate surveys or making erroneous decisions based on bad information is immeasurable. Competent hydrographers must be both well trained and well educated. Traditionally, training and education have been dealt with separately. Vendors of modern hydrographic instruments and software are in an excellent position to help combine the two. The concept of collaboration between hydrographic organization, hardware and software vendors, and academia can lead to the development of education/training modules that would benefit all in the industry.

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1. INTRODUCTION

One of the most challenging aspects of modern hydrography is the development of personnel. Technological advancements over the past few decades have led to significant changes in the methodology, and complexity, of data collection, processing and interpretation. While the science of hydrography has made great strides, education and training of the general workforce has not kept pace. This has led to a significant shortage of competent hydrographers, at all levels of the profession.

It is clear that an inadequately prepared workforce will be unable to conduct their work in an effective manner, leading to a negative impact on the economic aspects of hydrographic surveys and their products. The consequences of inadequate education and training are; misuse of software and hardware, low confidence in results, and expensive and inappropriate interpretation of those results.

Hydrographic education can take many forms from theoretical to hands-on, and have different methods of delivery, from in the classroom to out in the field. Ideally, it is a combination of all. This paper discusses some of the delivery methods utilized today and suggest some alternatives. Traditional education offerings are given by a variety of providers, including: naval academies, universities, private industry or other organisations through bi-lateral agreements or capacity building initiatives.

Any educational provision is a step in the right direction but certain formulas are known to get excellent results. For example, by combining vendor training with formal education, attendees can learn the required theory while putting it into practice; this will be explored through the paper. Industry placement and work experiences extend the interaction of students and their potential employers. Some training relies upon this, whereas others may concentrate on classroom and laboratory based activities. Vendor and manufacturer provided academic licensing programmes can be an effective way of making sure enough software and assets are available for educational activities, and can often be made with relatively minimal investment.

Practical training through short courses and workshops must meet the needs of the learner and the sponsor organization. A clear preference appears to support a modular based approach. Also, a mobile workforce requires that all individual modules, whenever and wherever completed, be compiled for some form of recognition. This could be a certificate of completion, certificate of competence, diploma or degree.

2. BACKGROUND

Preparation of individuals for the workforce varies from on-the-job-training through to university education. Most professions require a combination of both training and education, and there is a distinction. Training provides the leaner with the skills necessary to complete a particular task; for example; the procedure necessary to operate specific hydrographic data collection software, whereas education provides the background necessary to understand what that software does. Some would say that if a person has the appropriate education, they can easily be trained to operate any hydrographic related software package. On the other hand, someone without the appropriate education can be trained to operate a particular software package, given time, but will not have the educational background necessary to understand that software, or the ability to transfer that training to another application.

Modern hydrography is a profession that requires both training and education. It is a highly technical field requiring knowledge of computers, software applications, hardware integration, power sources, data communications, vessel operations and dynamics, and equipment mobilization, to name just a few. It is also a field that requires an extensive academic grounding in math, physics, geodesy, acoustics, oceanography, GIS, GPS, etc. In short, a hydrographer in today's workforce must be both well trained and well educated. It is for this reason that most hydrographic academic institutions and accreditation bodies emphasize both aspects of the learning process.

3. THE NEED FOR TRAINING

Ignoring either training or education in the development of professional hydrographers can lead to significant economic consequences. Hydrographers without the appropriate educational background can be trained to operate equipment and software; however, they will not have sufficient knowledge to evaluate the information being received and recorded. Modern hydrographic surveying equipment has enabled hydrographers to very accurately survey the seafloor. However, the equipment and software necessary are very complex and a complete understanding of all processes is necessary to meet specified requirements, and to show that the standards have been met. For example: multibeam echosounders require accurate sound velocity measurements at the transducer face as well as through the water column. A solid understanding of oceanography and acoustics is essential to know where, when and how to obtain sound velocity measurements. For another example: determination of the horizontal position of a depth measurement is relatively straight forward, especially with GPS. However, a good understanding of the science behind GPS and the propagation of errors is necessary to evaluate the uncertainty associated with that position.

With appropriate training, the acquisition of modern hydrographic data can be a relatively straight forward process. Determining the validity of that information; however, requires a much deeper understanding of the science, which can only be acquired through education. Evaluating what uncertainly is achievable given a particular environment and survey platform

is essential to planning a survey. Determining what uncertainty was achieved in the final product is essential to show that the desired standards have been met. If the hydrographer does not have the education necessary to evaluate system capabilities and data, before, during and after a survey, that data may turn out to be useless, requiring a complete resurvey at great expense.

Dredging contracts are based on the amount of material removed. Often, the volume is computed by differencing pre and post-dredge surveys. An intimate understanding of all aspects of the process from data collection, through processing and final volume calculations is necessary for proper volume calculations. Very slight changes in depth determination can lead to huge differences in the amount of money awarded, and some of these changes can be inserted into the results by the collection or computation process. For example; high-accuracy vertical GPS positioning is becoming very popular in hydrographic surveying. It has been shown that features appearing in data can be generated by GPS processing, and do not, in fact, exist. An intimate understanding of everything that goes into the determination of a depth value is essential.

Hydrographic training and education has traditionally been carried out by the organisations that provide hydrographic services. For the most part, these groups have not had the time or resources necessary to adequately address the education component. At the same time, many contracts are simply focussed on a single project or discrete operation and therefore the investment and benefit of training is not implicitly tied into the work. Rather it remains a secondary requirement of the personnel to have gained knowledge and experience to compete the works. Organisations that have invested in their staff often benefit from improved survey and cartographic standards of work, less risk, better business relationships and consequently healthier revenues.

4. TRAINING & EDUCATION – SETTING A STANDARD

Whilst the industry has benefitted from a considerable number of new technologies over the last decade or so, there has not been quite the same development in the education and training of personnel. True the advent of the internet, electronic storage media and computers have all enabled a great richness of data and information to be made available at the click of a mouse, or the press of a button, but the need is for structured and focused training that can produce a knowledgeable individual who is competent to survey, acquire data and deliver appropriate results. Where then does one access such a structure that will ensure the correct result from the training? One source is the FIG/IHO/ICA Standards of Competence for Hydrographic Surveyors and Nautical Cartographers[1] .

These Standards were originally developed in the early 1970's and are now on the 10th edition. They address the course content required to enable a student attending a course to be qualified and competent at a certain level. There are two levels, Category B level for technicians and those starting out in the surveying and cartographic disciplines associated

with the marine and nautical environment and the Category A level for the more advanced student who may take charge and lead a project. However whilst these standards offer a Minimum Standard of subjects and detail and knowledge of the specific elements they do not offer a prescriptive means to delivery of the course content. The balance between the practical laboratories and the class room lectures is not defined so as to allow organizations to mould the content into their particular course structure, timetable and schedule. The aim of the Standards is to promote best practice and minimum standards of competence in the personnel completing such a course. In order to achieve this, the Standards are provided free and organisations set their Courses to meet the Standards and then submit their courses for review by the International Standards Board that is made up of experts from FIG, IHO and ICA.

Around the world there are less than 50 such recognised courses (see Figure 2) at the International level. Unfortunately there is an incomplete picture of the total number of official courses being provided but with the changes and developments in training that we are seeing it is likely that a considerable number of additional courses could submit for the Category B or Category A level.

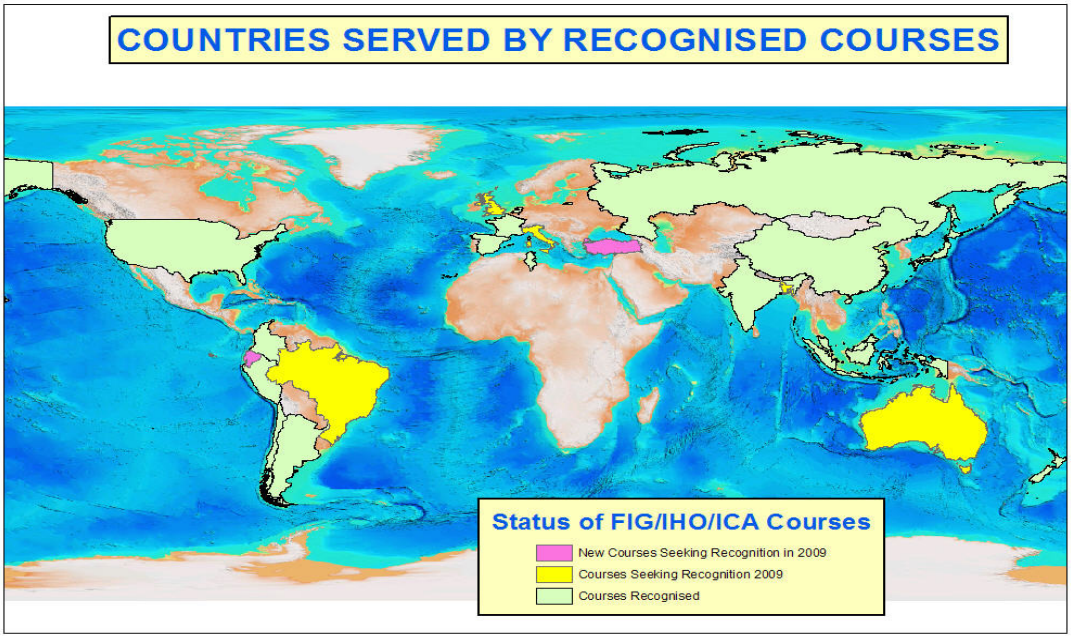

Figure 1: The Distribution of FIG/IHO/ICA Category A & Category B Recognised Courses

Recognising the practical nature of the work involved there is an emphasis on the practical work and field experience. These elements are representative of the early stages in the data flow of Hydrographic data from acquisition to final product but more and more there are also lengthy practical periods devoted to the processing and management of the data. However this can lead to a serious aspect for the organisation providing the course and that is the availability and access to software and hardware assets for the training of students. There are many options and often the students are required to gain knowledge of quite complex systems.

To this end there is a clear benefit in combining the Standards of the FIG/IHO/ICA Board and its documents to that of the training modules of the vendors and manufactures who have both access to their resources but also a comprehensive appreciation of the capabilities and limits of their products and services.

In terms of building capacity this concept of grouping the practical user support functions with the modules and topics covered by the Standards allows the individuals to gain a recognised level of training.

5. TRAINING – DELIVERING THE MESSAGE

This partnering, of both the provider of the survey system components and the academic institution with its structure and focus on the theoretical aspects, offers a tantalising mix of capabilities to deliver cost effective training at a level appropriate for the audience whilst meeting the recognised international Standards. A win-win situation.

Vendor software and hardware training plays a significant role in the development of hydrographers, in both academia and industry. The need for hands on experience within academic programs is very well understood. In order for students to take part in data collection and processing exercises, they must become familiar with the software and hardware they will be using. Often, industry vendors will supply software and equipment, along with training, at very reasonable rates. These academic partnerships are advantageous to all parties involved. Vendors get exposure to up-and-coming hydrographers and academia gets access to up-to-date software and equipment, on very reasonable terms.

In some cases, vendor software can be used as the basis for academic study. Going through the setup and configuration of hydrographic data acquisition or processing software provides incredible opportunities to segue into discussions of basic principles. For example, setting up the geodetics of a project provides an opportunity to discuss geodesy, datums and map projections. Setting up vessel configurations allows for the opportunity to discuss the effect of vessel offsets and vessel coordinate systems, as well as how errors propagate throughout the entire system. Not only do students have the opportunity to discuss the application of concepts, they also have the opportunity to see the effects of applying theory in a real-world situation. An entire course, such as Hydrographic Data Management, can be based on the collection, processing and analysis of real-world hydrographic data using vendor supplied software and hardware.

6. TRAINING – INCLUDING THE STAKEHOLDERS

Hydrographic service providers often hire vendors to train personnel on the use of their software or equipment. The emphasis of the training is to provide the operators with the tools necessary to use the products, usually assuming the trainees have the background necessary to

understand the concepts involved, which is often not the case. This type of training provides an excellent opportunity to add education to the training process. For example, a standard software training course may include the use of a tool to compute tides from GPS derived heights at the vessel. This would be a good teaching opportunity to enhance the training experience by discussing the issues surrounding the use of GPS heights in hydrographic surveying, including:

- The direct measurement of the seafloor relative to the reference ellipsoid, removing the effects of heave and tide.
- Vertical datum relationships including the geoid-ellipsoid separation, sea surface topography, and hydrodynamic modelling.
- The effect of pitch and roll on the vertical separation between antenna and reference point (see Figure 2).

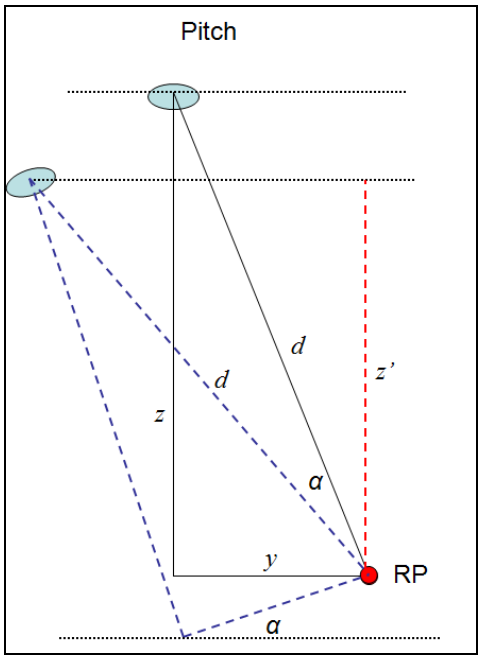

Figure 2: Effect of Pitch and roll on antenna to reference point vertical separation

In many academic programs, training in the use of vendor equipment and software is not nearly as in-depth as it could be. In many training courses, the academic side of the issues usually receives little or no attention. What is need is a complete integration of the two. Modules should be developed using hydrographic data collection and processing software as the basis for presenting theory. Each module could be used as a stand-alone training exercise for industry, and a series of which could be put together to make up a portion (or all) of an academic course. Modules would be generated to meet international standards, such as those in the FIG/IHO Standards of Competence for Hydrographic Surveyors syllabus. Industry and academia could use the models as part of an application for FIG/IHO program accreditation. Industry could also use the modules for employee career development.

7. CONCLUSIONS

Whilst the vendor may have an initial interest in selling a piece of hardware or software, there is a longer term relationship to be built with both the educational establishment and the students themselves who, it is hoped, will see the benefits of the systems used and upon making their way in the world will adopt and use these system.

Educational and training establishments themselves are able to leverage the expertise and knowledge of the vendors to better deliver practical and up-to-date technology awareness. This has often, in the past, required massive resources and personnel but the modular approach and shared cooperation, to focus a group of students on a specific function and operation using the appropriate tools is proving very successful. A mix of theory and practical classes offers the opportunity to develop the knowledge and skills to both undertake relatively standard tasks and to solve problems.

REFERENCES

[1] M-5, The Standards of Competence for Hydrographic Surveyors and M-8, The Standards of Competence for Nautical Cartographers, IHO Publication available at http://www.iho-ohi.net/english/home

BIOGRAPHICAL NOTES

David Dodd received a B.Sc. and M.Sc. in Surveying Engineering from the University of New Brunswick (UNB) in Fredericton, NB, Canada. He completed a PhD in Marine Science at the University of Southern Mississippi (USM). Dr. Dodd spent eight years conducting research (high-accuracy GPS) and directing the Hydrographic Science Master's program at USM and is now a Senior Research Associate with the department of Geodesy and Geomatics Engineering at UNB. His current research activities are directed towards investigating all aspects of hydrographic surveying with respect to the ellipsoid.

Gordon Johnston is director of Venture Geomatics Limited, an independent consulting and technical training group in the UK. He joined Decca Survey as a field surveyor, working in Europe and Africa and became Chief Surveyor in 1993. In 2004 he started consulting for non-government, commercial and international organisations providing strategic technical, market and commercial services. He is the chair of the FIG/IHO/ICA International Board on the Standards of Competence for Hydrographic Surveyors and Nautical Cartographers.

Andrew Hoggarth received a B.Sc. in Mapping Science from the University of Luton in Bedfordshire, England. He then spent 6 years at Racal Survey / Thales GeoSolutions specialising in hydrography and specifically Multibeam Survey. In 2003 Andy moved to Fredericton, Canada to be the Customer Services Manager of CARIS, in 2007 he moved into the position of Marketing and Sales Manager the position that he still holds.

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